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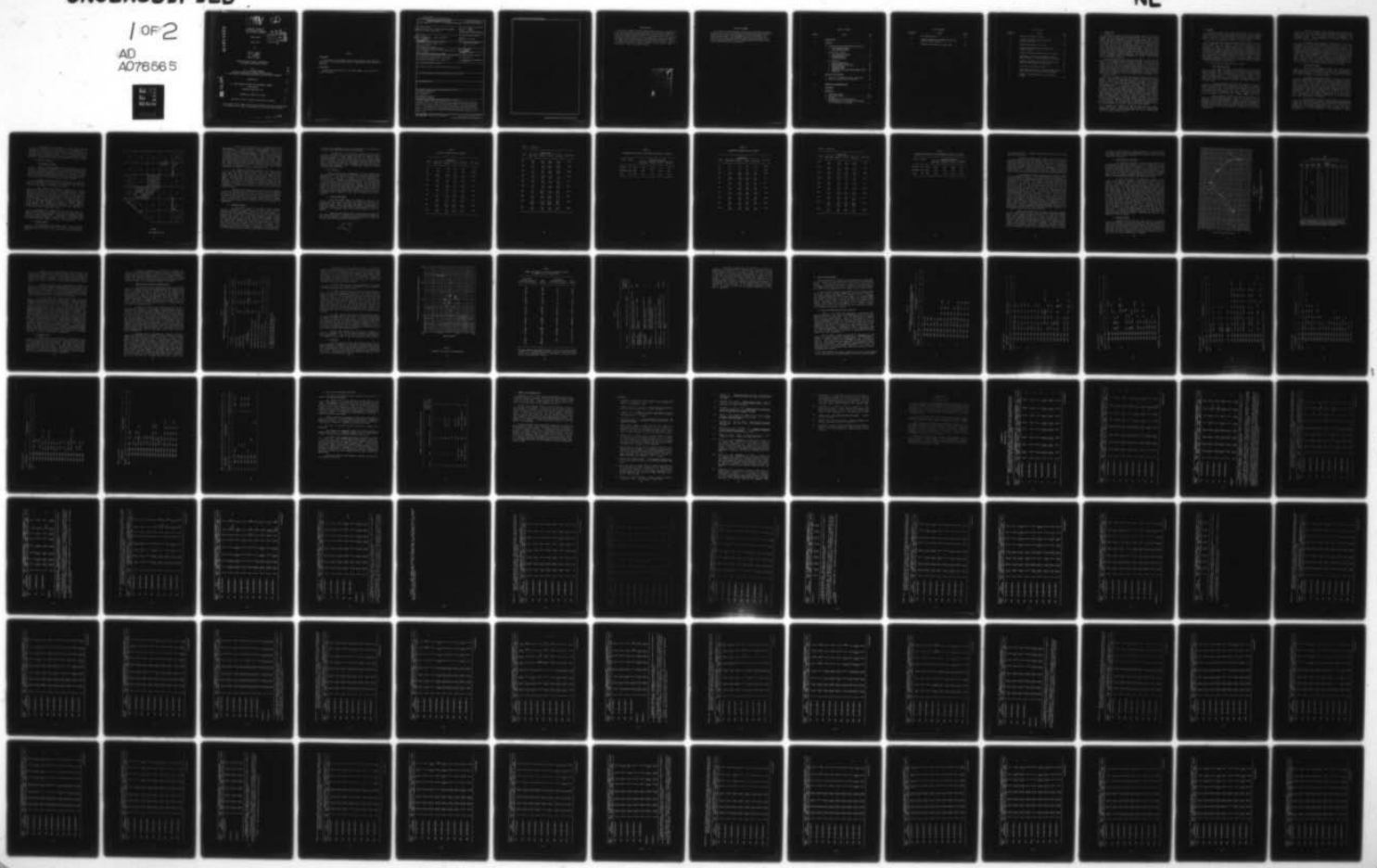

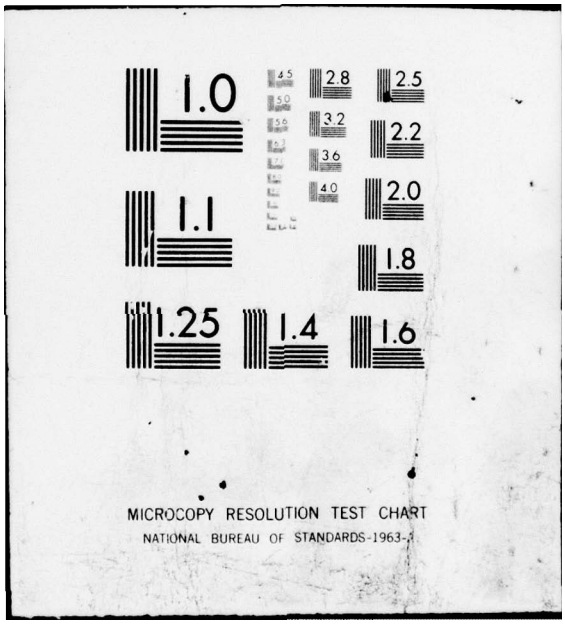
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BIOLOGICAL TESTING OF ROCKY MOUNTAIN ARSENAL FOR PHYTOTOXIC SUBSTANCES

FINAL REPORT

APRIL 1979

By

DAVID R. COGLEY
LYLE E. CRAKER
C.D. TORGESON
DAVID L. SIROIS

WALDEN DIVISION OF ABCOR, INCORPORATED
WILMINGTON, MASSACHUSETTS 01887

and

DR. W. DICKINSON BURROWS
(CONTRACTING OFFICER'S TECHNICAL REPRESENTATIVE)
U.S. ARMY MEDICAL BIOENGINEERING RESEARCH AND DEVELOPMENT LABORATORY

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David R. Cogley
Lyle E. Craker
C.D. Torgeson
David L. Sirois

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Soil samples from Rocky Mountain Arsenal were biologically tested for phytotoxins to see if such results were consistent with chemical analytical data from the coring program of the US Army Office of the Surgeon General (OTSG). The phytotoxicity data do not indicate the presence of phytoxins except in areas shown to be contaminated on the basis of chemical analytical data. Further phytotoxicity tests of OTSG coring program samples are not required.

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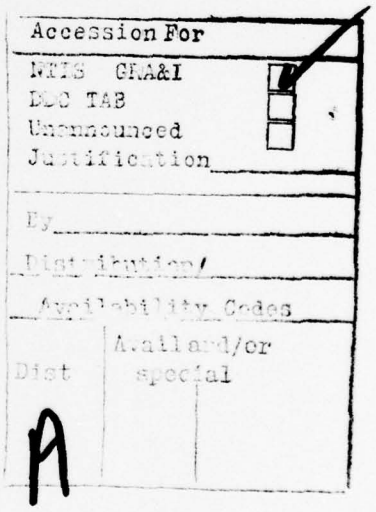

EXECUTIVE SUMMARY

Soil samples from Rocky Mountain Arsenal were biologically tested for phytotoxins to see if such results were consistent with chemical toxicity analytical data from the coring program of the US Army Office of the Surgeon General (OTSG). The phytotoxicity data do not indicate the presence of phytoxins except in areas shown to be contaminated on the basis of chemical analytical data. Further phytotoxicity tests of OTSG coring program samples are not required.

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I. INTRODUCTION

Military and Industrial wastes have been disposed of at Rocky Mountain Arsenal (RMA) from 1941 to the present time. Shell Chemical Company has been manufacturing pesticides there since 1952. Fluid wastes have been transported via unlined ditches and by waste sewers to both unlined basins and to lined basins. Solid wastes have been placed in trenches and pits and subsequently covered. It is possible that some toxic materials may have migrated from disposal areas to other areas where they may pose an environmental hazard. The United States Army is funding a multifaceted study of RMA which includes an evaluation of available literature for compounds present at RMA, soil coring and chemical analysis, characterization of the geology and geohydrology of RMA, wastewater treatment technology, soil reclamation technology, animal toxicology studies, and phytotoxicity testing. Other studies are also underway or planned.

The primary objective of the studies at RMA is to minimize the possibility of damage to humans, animals, and plants resulting from the effects of toxic materials on or emanating from RMA. To this end, many types of studies are being simultaneously performed. Some of the studies may seem rather specialized and applicable only to one type of target organism but due to the waste disposal history and hydrogeology of RMA, the finding of any single toxic compound is a good reason to suspect the occurrence of other toxic compounds at the same site. Thus, the finding of a phytotoxin could lead to the finding of compounds toxic to humans or animals.

In order to judge the full significance of the phytotoxicity data[25], one may wish to review the history of RMA and its hydrogeology. The history of RMA including tenant activities, earlier waste disposal surveys, and ecological studies, is reviewed in an earlier report [20]. An idea of the number of compounds which may be present in RMA water and soils can be obtained from a series of reports [6,7,9,18,19,20,21]. The transport of some compounds in groundwater pollutant plumes at RMA has been reviewed in connection with an analysis of chemical analytical data from the OTSG coring program. The interesting feature of that data is that chemical analysis of the OTSG core samples focused on materials which did not move via detectable groundwater pollutant plumes. Focusing on chemical analysis of a limited number of compounds (for economic reasons) decreased the chances of delineating the extent of pollutant plumes known from previous work to exist at RMA. Phytotoxicity tests of good precision are useful in such circumstances for the detection of phytotoxic compounds without previous knowledge of the chemical identity of the phytotoxin.

In summary, toxic materials at RMA may pose hazards to humans, plants, and animals. Phytotoxicity tests of RMA soil samples yield information on the location of phytotoxins and also on the possible location of human and animal toxins.

II. APPROACH

The primary purpose of the phytotoxicity tests at Boyce Thompson Institute was to discover the presence of phytoxins in soil at RMA. Careful specification of experimental protocols and careful interpretation of results allow one to judge the extent to which measured effects reflect the parameters one would like to determine.

Basically, the tests involved the germination of seeds of selected plants in samples of soil taken from different depths at various locations at RMA. These tests detect: inhibition or retardation of the germination of seeds of monocotyledonous and dicotyledonous plants, retardation of seedling growth and development, interference with chlorophyll development, necrosis of foliage, stem collapse and/or death of the plants. Where obvious phytotoxicity symptoms are observed with a particular sample, such symptoms may be attributed to specific contaminants identifiable by chemical analysis of the soil sample. In cases where chemical analysis fails to indicate the presence of contaminants, the observed phytotoxicity signifies that an unknown phytotoxic compound is present and requires identification.

A. FACTORS AFFECTING INTERPRETATION OF RESULTS

1. Soil Sampling Factors

Soil samples utilized in the phytotoxicty tests were from known locations at RMA. The precise nature of the drilling procedure, sample treatment, sample transportation, and sample storage can affect physical, chemical, and biological properties of soil causing changes in plant growth response. If substantial changes did occur in the samples from RMA, the growth tests performed at Boyce Thompson Institute may not accurately reflect the presence or absence of phytotoxins in soils at RMA.

Drilling procedure can affect test results if soil core segments are contaminated with phytotoxins from other core segments. This is important if one is striving for high precision on the vertical scale at one drill hole. Since five foot core segments were utilized, this problem was probably not serious. Also, contamination from other drill holes can be a problem if the coring rig (auger, sample containers, transfer tools) are not well cleaned between drill holes.

Sample treatment can affect the stability of phytotoxins in soils. Air drying retards biological growth but enhances the rate of evaporation of volatile compounds. Sealing in air tight containers preserves volatile organics but may enhance anaerobic decomposition. Mixing of each soil core allows for a determination of the average soil conditon but may enhance loss of volatiles, causing dilution of stratified pollutants, and provide conditions conducive to intersample contamination.

Conditions during sample transportation and storage can affect test results in many ways. Permeable sample containers allow the rapid escape of volatile compounds and air oxidation of compounds. High temperatures favor loss of volatiles, chemical transformation, and biological growth. Lack of protection from outdoor conditions can result in leaching by rainfall.

In essence, for any given soil sample, almost any environment other than the original temperature, contiguous air, soil, and groundwater could cause changes in phytotoxicity test results. The changes in test results could be due to a change in the concentration of phytotoxins within the sample or to changes in physical, chemical, or biological properties which might be described as "poor soil". Dicyclopentadiene is a good example of a phytotoxin which could be present in soil (or within groundwater contained in soil) at RMA and yet be absent from a sample.of that soil delivered to Boyce Thompson Institute. Microbial growth in a sample stored at warm temperatures in a sealed container could cause nitrate depletion, sulfide formation, a shift to acidic pH, and clogging of soil pores thus changing a "good soil" to a "poor soil" and causing apparent phytotoxicity signs.

2. Plant Growth Factors

The results of phytotoxicity tests using indicator plants depend on the plants making physical contact with the phytotoxins, plant sensitivity to the phytotoxins, and correct interpretation of plant growth responses. The latter refers to a recognition of phytotoxic signs in the growth of indicator plants.

The seeding and growing of plants in the test soil samples assures contact between plant roots and phytotoxins. However, there are many soil factors which can complicate the root-phytotoxin interaction. These soil factors relate directly to soil sample treatment, transportation, and storage (see previous section). A phytotoxic chemical may become unavailable to the plant due to inactivation or low concentrations caused by volatilization, leaching, photo-decomposition, chemical decompositon, microbial decomposition, or adsorption on soil colloids[15]. Other inhibiting factors can be due to "poor soil". Poorly structured soil may present a physical barrier to root penetration. Low amounts of soil nutrients and abnormal soil pH could prevent physiological development of the plants.

The sensitivity of plants to phytotoxins varies according to the age, rate of growth, morphology, genetic inheritence, membranes, enzymes, and metabolic pathways of the plants[15,22]. Generally, the younger and more rapidly growing plants are the most sensitive to phytotoxins. In addition, temperature, light, moisture, pH, and/or nutrient stress can make plants more or less susceptible to phytotoxins[15,22].

Observation and interpretation of plant growth responses to test soil samples provide the basis for deciding whether or not phytotoxins are present. It is important to accurately identify an abnormality and to distinguish whether it was induced by phytotoxins or by some other environmental factor. This is accomplished through maintenance of environmental growth conditions, recognition of specific phytotoxic induced abnormalities, and comparison to control plants.

B. EXPERIMENTAL APPROACH

1. Soil Sampling Program

The soil sampling program for the Rocky Mountain Arsenal utilized a rectangular grid pattern for locating sampling sites (see Figure 1). Grid spacing varied for the various sections of RMA according to the intensity of sampling of the particular sections. In one of the most extensively sampled sections, section 36, grid spacing was 440 feet. In less extensively sampled sections, grid spacing was 880 feet. For sections 8 and 9 cores were drilled at random locations.

Depending on the available drilling rig, soil cores were drilled at designated sites to seven feet, groundwater, or bedrock[5]. Each core was divided into segments of 0-2 feet, 2-7 feet, and subsequent five foot segments to the end of the core[1].

Each sample as collected was labeled with a four-part eleven digit identification code in the form 00-0000-0000-0. In the identification system, the first two digits specify the section at RMA, the next four digits are the number of feet east of the section's southwest corner + 1000, the following four digits are the number of feet north of the section's southwest corner + 1000, and the last digit is the designator of sample depth[1,5]. If the depth designator is 1, the 0-2 feet sampling depth is indicated. For samples deeper in the profile, the depth designator is increased by 1 for each subsequent 5 foot segment. Thus, 26-2320-3640-2 designates a soil sample collected from section 26, 1320 feet east of the SW corner, 2640 north of the SW corner, and at a depth of 2-7 feet.

The cored soil segments were air dried (no direct sunlight), passed through a no. 4 screen to remove large stones and obtain some mixing, and then passed three times through a chambered sample splitter to ensure homogeneity[1]. Subsamples of approximately 1000 grams were subsequently placed in capped 2-liter glass jars and shipped to greenhouses at Boyce Thompson Institute, Yonkers, New York.

2. Primary Testing

The phytotoxicy test procedure used by Boyce Thompson Institute for the evaluation of RMA soil samples is an adaption of herbicide screening procedures which have been used since the early 1940's[17]

FIGURE 1

CORE SAMPLING SITES

Indicator plants selected for this study were sugar beet, Beta vulgaris L., cv. Great Western; mustard, Brassica nigra L., cv. Florida broadleaf; perennial rye grass, Lolium perenne L., cv. NK-100; and foxtail millet, Setaria italica (L.) Beaouv. cv. Golden (all available from the Stanford Seed Company). These plants represent both the monocotyledonous (rye grass and foxtail millet) and dicotyledonous (sugar beet and mustard) classes of plants. Foxtail millet and mustard are standard screening plants used at Boyce Thompson Institute. Sugar beet and perennial rye grass have been previously used at Boyce Thompson Institute and are samples of plant species that could be grown at RMA. These indicator plants are best classfied as having intermediate sensitivity to phytotoxins[17]. They also fulfill other listed requirements for phytotoxin indicator test plants[4,15].

Soil samples from RMA were placed in fiber trays (19 cm X 13 cm X 7.6 cm), firmly pressed, and marked with 4 rows. Seeds of rye grass (about 100 seeds), foxtail millet (about 100 seeds), mustard (about 100 seeds), and sugar beet (about 25 seeds) were sown into separate rows and covered to a depth of approximately 1 cm with soil sample. (All seeds were coated with the fungicide, Arasan, prior to planting). The trays were sprinkled to optimum moisture level for seed germination and placed in a greenhouse. Greenhouse temperature was maintained at minimums of 15°C and 21°C during the night and daytime, respectively. In the case of controls, the soil used for planting was greenhouse compost.

Observations were made at weekly intervals on the emergence of seedlings, growth rate, chlorosis, foliage necrosis, formative effects, and other abnormalities. After 3 weeks, plants were measured for median growth and removed from the soil. Roots were examined for necrosis and any abnormality, such as stubby growth (root hair suppression), and maximum root lengths recorded. Plants grown in greenhouse compost served as the basis for comparison in all observations and measurements.

3. Secondary Testing

In cases when it was not clear whether plant responses were due to phytotoxic substances or to inherently difficult soils, secondary tests were conducted. Examples of the latter include; 1) soils of high clay content developing a crust and thus inhibiting seed emergence and 2) soils poor in nutrients which would result in poor growth of the plants. To eliminate these problems, secondary testing involved some modifications of the primary test procedure. Problem soil samples were seeded with the same plant species as in primary testing but after the seeds were sown, they were covered with a thin layer of washed sand to prevent crusting of the soil surface. This allowed for a more normal emergence of seedlings. In addition, after the seeds were covered, the trays were watered with a balanced fertilizer (Miracle-Gro) to make up any nutrient deficiencies of the soil.

All trays were subsequently placed in the greenhouses and phytotoxicity assessed in the same manner as in the primary tests.

Confidence in any particular phytotoxic test result increases with the number of evaluation criteria demonstrating an observable phytotoxic change between indicator and control plants. Highest confidence is in those tests where all four indicator plants develop phytotoxic symptoms in both the initial and the modified repeat test. A difference in growth of 20% between indicator test plant and control plant was generally not considered significant unless accompanied by other phytotoxic signs. A difference in growth of 100% was considered very significant.

C. DATA ANALYSIS

Factors affecting the interpretation of plant response data have been outlined in Section II-A and some of them are quantitatively evaluated here. These factors include: 1) control experiments, 2) normalization of test data, 3) blocking effects, 4) secondary tests, and 5) precision. Treatments presented here are basic and appropriate to the reproducibility of the data evaluated. The analyses deal principally with median top growth data. Several more sophisticated statistical analyses have been applied to emergence ratings, mean top growth, and median top growth but these analyses were discarded in favor of simpler tabular and graphical displays. In general, the plant response data show a consistent overall pattern with a level of precision which might be expected of tests with the degree of replication evidenced.

1. Control Experiments

The plant growth tests were conducted in groups of soil samples referred to here as blocks. For each block of tests, two (occasionally one) control tests were performed with seeds sown in greenhouse compost. Median top growth data (Table 1) and maximum root growth data (Table 3) for these controls were examined to obtain an estimate of the reproducibility of test results (Tables 2 and 4) for controls.

Mean top growth data of Table 1 were analyzed by computing the standard deviation (n-1 statistic) of each data pair (triplet for B19) for each species. Standard deviation values for primary and secondary tests were computed for each species as:

$$s = \sqrt{\frac{\sum_{i=1}^{n} S_i^2}{n}}$$

TABLE 1

MEDIAN TOP GROWTH DATA FOR CONTROLS

Block	Length (cm)				Start Date
	Sugar Beet	Mustard	Millet	Rye Grass	
B1	5.5	5.0	6.0	9.0	2/10
B2	6.5	5.5	8.5	10.0	2/18
B3	5.5	5.0	8.5	9.5	3/24
	5.5	5.0	6.0	9.0	
B4	5.5	5.7	5.1	10.5	3/31
	5.2	5.2	5.0	10.3	
B5	6.6	5.3	5.5	12.2	4/1
	6.1	5.8	5.3	11.5	
B6	6.2	7.4	8.1	14.8	5/5
	7.1	7.1	8.3	13.4	
B7	8.5	9.1	8.8	3.8	5/13
	8.7	8.8	8.6	12.9	
B8	9.0	11.0	13.0	14.6	5/19
	8.9	7.1	10.1	11.5	
B9	11.9	10.1	14.4	15.7	5/26
	11.2	9.2	13.9	15.3	
B10	8.3	8.1	11.5	15.0	7/20
	6.3	6.2	11.3	14.1	

TABLE 1 - Continued

Block	Length (cm)				Start Date
	Sugar Beet	Mustard	Millet	Rye Grass	
B11	10.2	10.1	11.8	13.1	7/22
	9.8	9.4	10.4	12.8	
B12	8.1	7.9	12.1	13.1	7/28
	7.2	8.3	13.1	13.8	
B13	5.7	6.2	8.0	12.0	8/26
	6.5	7.0	10.0	10.0	
B14	4.6	4.6	6.2	7.2	8/27
	3.7	4.6	5.1	8.0	
B15	3.6	4.0	5.5	8.0	9/1
	3.7	3.9	3.5	6.8	
B16	7.2	6.9	6.5	13.3	4/13
	4.2	4.0	0.0	8.5	
B17	8.1	10.2	9.7	15.2	4/21
	7.2	10.0	5.8	13.5	
B18	8.4	8.0	13.2	15.4	6/8
	9.0	14.5	15.0	7.0	
B19	9.8	8.7	14.2	15.2	6/18
	9.5	9.3	14.9	16.5	
	8.5	8.5	15.5	17.1	
B20	6.3	6.9	8.7	9.4	9/20
	6.6	7.5	8.4	11.2	

TABLE 2

STANDARD DEVIATION VALUES FOR MEDIAN TOP GROWTH OF CONTROLS

Tests	Blocks	Standard Deviations			
		Sugar Beet	Mustard	Millet	Rye Grass
Primary	B3 - B15	0.56	0.91	1.02	1.99
Secondary	B16 - B20	1.06	2.27	2.62	3.19
Total	B3 - B20	0.73	1.42	1.63	2.38

TABLE 3

MAXIMUM ROOT GROWTH DATA FOR CONTROLS

Block	Length (cm)				Start Date
	Sugar Beet	Mustard	Millet	Rye Grass	
B1	5.5	6.0	8.0	9.0	2/10
B2	6.6	9.1	8.0	9.8	2/18
B3	5.4	9.5	8.3	5.3	3/24
	4.4	6.4	6.3	4.8	
B4	4.6	3.8	6.3	6.7	3/31
	5.9	5.9	5.9	6.4	
B5	5.2	4.8	5.8	5.1	4/1
	4.9	5.2	5.6	5.3	
B6	4.5	4.2	6.5	5.6	5/5
	5.0	4.3	5.2	10.1	
B7	3.5	3.4	3.6	5.9	5/13
	3.5	5.0	6.9	7.0	
B8	5.0	5.7	13.7	7.0	5/19
	4.3	5.6	7.0	10.3	
B9	4.5	5.2	8.9	9.8	5/26
	3.5	6.6	6.3	7.1	
B10	9.2	6.2	9.1	9.7	7/20
	6.0	4.7	6.2	9.3	

TABLE 3 - Continued

Block	Length (cm)				Start Date
	Sugar Beet	Mustard	Millet	Rye Grass	
B11	6.1	6.9	8.5	10.3	7/22
	6.3	9.3	8.3	8.8	
B12	4.2	7.0	8.9	9.7	7/28
	3.8	5.9	8.9	9.1	
B13	4.5	4.3	6.1	5.0	8/26
	3.9	4.5	6.3	6.6	
B14	3.0	10.7	3.3	5.7	8/27
	4.0	4.0	7.1	8.3	
B15	2.8	5.1	6.8	9.9	9/1
	3.0	7.5	7.5	7.3	
B16	3.1	2.9	4.8	6.5	4/13
	3.5	1.0	0	4.1	
B17	5.7	6.9	6.2	10.4	4/21
	3.4	8.9	3.2	6.2	
B18	5.0	4.1	3.8	9.1	6/8
	3.0	4.3	5.5	10.1	
B19	3.8	7.0	6.3	10.3	6/18
	5.4	4.9	7.8	10.4	
	3.5	6.9	9.5	13.1	
B20	3.6	2.1	3.9	6.7	9/20
	3.3	4.4	8.4	5.5	

TABLE 4

STANDARD DEVIATION VALUES FOR MAXIMUM ROOT GROWTH OF CONTROLS

Tests	Blocks	Standard Deviations			
		Sugar Beet	Mustard	Millet	Rye Grass
Primary	B3 - B15	0.82	1.84	1.88	1.51
Secondary	B16 - B20	1.08	1.25	2.46	1.76
Total	B3 - B20	0.90	1.70	2.06	1.59

and listed in Table 2. Standard deviations were higher for secondary than for primary tests.

Approximate estimates of the overall coefficient of variation may be calculated for each species. Mean values, m, of mean top growth for controls in blocks B1 to B20 are 7.2, 7.4, 9.1, and 11.8 for sugar beet, mustard, millet, and rye grass, respectively. Corresponding values for the coefficients of variation are 10, 19, 18, and 20% for sugar beets, mustard, millet, and rye grass, respectively. One should thus not be at all surprised at variations of $\pm$20% for median top growth values or, in other words, differences of $\pm$20% between two tests within the same block should not be considered significant.

The frequency of erratic responses may be judged by noting their occurrence for controls. Since the coefficient of variation, CV, is not normally distributed one cannot estimate the frequency of occurence of erratic events from CV values. For sugar beets block B16 had values of 7.2 and 4.2. For mustard extreme values were for B8, 11.0 and 7.1, and for B18, 8.0 and 14.5. For millet, block B16 had values of 6.5 and 0.0. For rye grass extreme values were for B7, 3.8 and 12.9; for B16, 13.3 and 8.5; and for B18, 15.4 and 7.0. Thus, out of 72 pairs (and triplets) of values, seven were large enough to be termed erratic ($30\% \leq CV \leq 141\%$). This could be interpreted to mean that approximately 10% of the test values will be erratic ($CV \geq 30\%$). Of most importance are two of the values; millet, block B16, with values of 6.5 and 0.0 and rye grass, block B7, with values of 3.8 and 12.9. The implication in these two cases is that one value for each is sufficiently normal to indicate the absence of a phytotoxin whereas the other is low enough to indicate the presence of a phytotoxin. Thus, based on data for controls, we may estimate that the approximate rate at which a false indication of phytotoxin presence might occur is one to two percent. Strictly speaking, estimates concerning reproducibility should come from replication of RMA sample test results. Since this is not possible we must rely on control test data.

Maximum root growth data for control species was analyzed to see if results were similar to those obtained for median top growth. Table 4 shows standard deviations of 0.90, 1.70, 2.06, and 1.59 for sugar beets, mustard, millet, and rye grass, respectively. Median values, m, of maximum root growth for blocks B1 to B20 were 4.52, 5.65, 6.63, and 7.88 for sugar beet, mustard, millet, and rye grass, respectively. From these, the following estimates for coefficients of variation are obtained: 20, 30, 31, and 20% for sugar beet, mustard, millet, and rye grass, respectively. Examination of Table 3 indicates that the frequency of erratic data for maximum root growth of controls

is similar to that observed for median top growth. In the interest of conserving available resources, and expecting similar conclusions from root growth data, further examination of root growth data was deemed unjustified at this time.

2. Normalization of Test Data

The procedure employed (in the original report) for normalization of test data consisted of dividing measured test values by corresponding mean values for controls. A slightly different procedure (described below) was utilized in the present report in an effort to reduce the effects of erratic values observed for some control runs. In both cases the purpose of the normalization procedure was to eliminate effects of light, temperature, and other temporally common factors by comparing growth of each test plant to that of control plants of the same species planted at the same time and place.

To obtain estimates of the magnitude of seasonal variations in the growth of controls, the median top growth values for controls were separately plotted for each species versus time as the abscissa. Reasonably smooth curves could not be drawn through the resulting points. To achieve some degree of averaging of the data, the data were pooled. For each control run the median top growth values were summed (Table 5). These data were then plotted versus calendar month and arbitrary curve was drawn through the plotted points (Figure 2). This provides a good visual display of within-block, between-tray reproducibility and a measure of growing conditions in the greenhouse. Block 16 shows unusually poor reproducibility. Blocks 13 and 14 show unusually poor growth responses. Since the reproducibility was good for these two blocks it was assumed that growth conditions were poor for these particular blocks as a group and not just for the controls. Totals by species were computed from Table 1. These were divided by the grand total for Table 1 to obtain the percentage of composite growth response due to each species. These values are 20.3, 20.7, 25.7, and 33.3% for sugar beets, mustard, millet, and rye grass, respectively. To obtain the normalization value for each species and test block the species-percentage values were multiplied by the smoothed-composite-values of Figure 2. Normalization values for each species are listed in Table 5.

3. Blocking Effects

Blocking effects can bias test results if non-random designs are employed. For any block of tests there are environmental factors which can affect that block differently from other blocks. To some extent blocking effects are compensated by normalization procedures such as those described above. The degree of compensation approaches 100% only if the cultural conditions are uniform within the block and the controls respond in the same way as the test plants to those factors for which compensation is attempted.

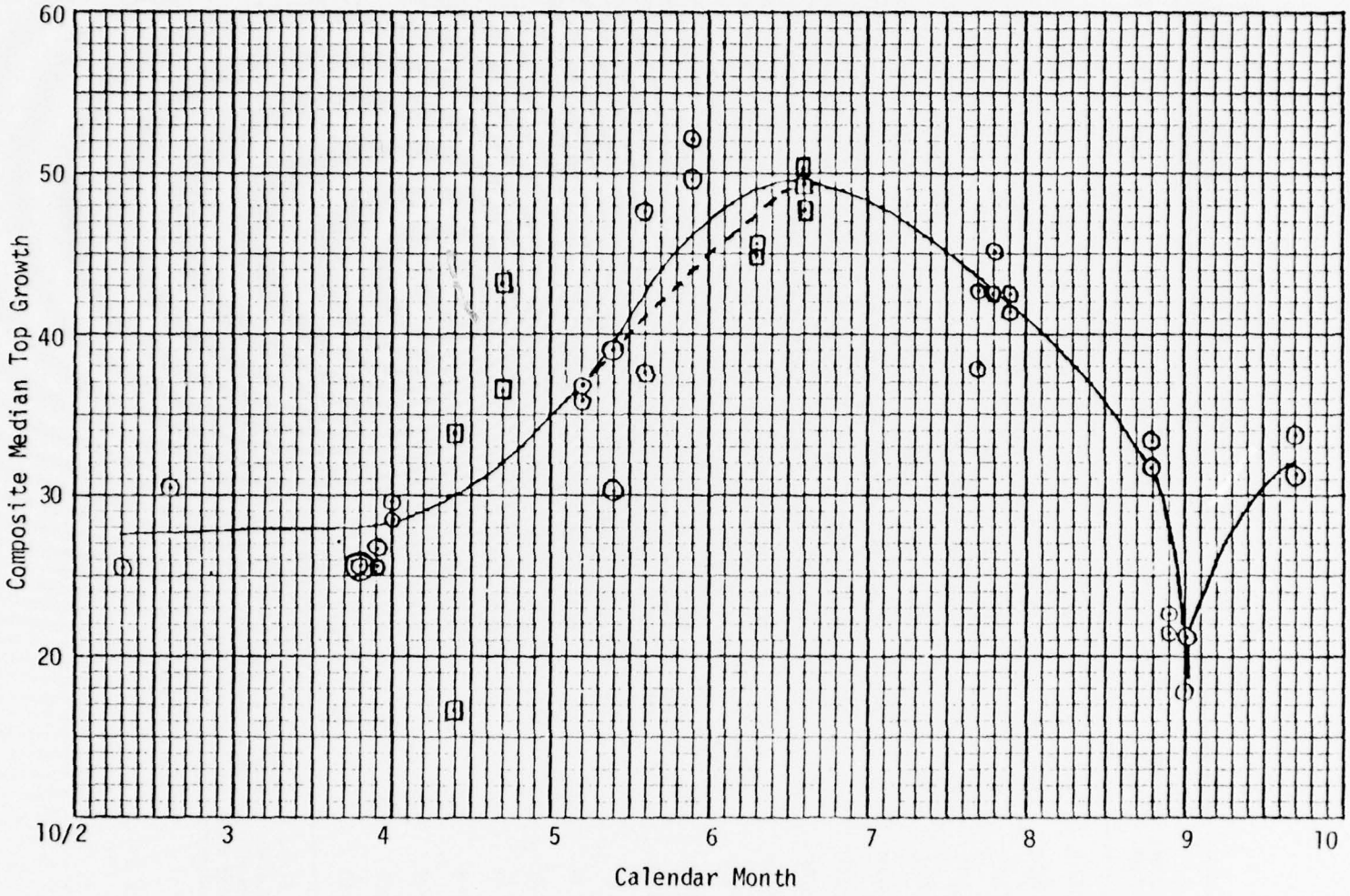

FIGURE 2

SEASONAL DEPENDENCE OF COMPOSITE MEDIAN TOP GROWTH VALUE FOR CONTROL

TABLE 5

COMPOSITE MEDIAN TOP GROWTH VALUES FOR CONTROLS

Start Date	Primary Tests	Secondary Tests	Growth Values	Smoothed Value from Figure 1	Sugar Beet	Mustard	Millet	[illegible] Grass
2/10	B1		25.5	27	5.5	5.6	6.9	9.0
2/18	B2		30.5	28	5.7	5.8	7.2	9.3
3/24	B3		25.5 - 25.5	28	5.7	5.8	7.2	9.3
3/31	B4		26.8 - 25.7	28	5.7	5.8	7.2	9.3
4/01	B5		29.6 - 28.7	28	5.7	5.8	7.2	9.3
4/13		B16	33.9 - 16.7	30	6.1	6.2	7.7	10.0
4/21		B17	43.2 - 36.5	32	6.5	6.6	8.2	10.7
5/05	B6		36.5 - 35.9	37	7.5	7.7	9.5	12.3
5/13	B7		30.2 - 39.0	39	7.9	8.1	10.0	13.0
5/19	B8		47.6 - 37.6	41*	8.3	8.5	10.5	13.7
5/26	B9		52.1 - 49.6	44*	8.9	9.1	11.3	14.7
6/08		B18	45.0 - 45.5	47*	9.5	9.7	12.1	15.7
6/18		B19	47.9 - 50.2 - 49.6	49	9.9	10.1	12.6	16.3
7/20	B10		42.9 - 37.9	44	8.9	9.1	11.3	14.7
7/22	B11		45.2 - 42.4	43	8.7	8.9	11.1	14.3
7/28	B12		41.2 - 42.4	42	8.5	8.7	10.8	14.0
8/26	B13		31.9 - 33.5	32	6.5	6.6	8.2	10.7
8/27	B14		22.6 - 21.4	23	4.7	4.8	5.9	7.7
9/01	B15		21.1 - 17.9	20	4.1	4.1	5.1	6.7
9/20		B20	31.3 - 33.7	32	6.5	6.6	8.2	10.7

* In the original construction of Figure 2, a plotting error was made which resulted in smoothed values of 41, 44, and 47 for blocks B8, B9, and B18, respectively. More appropriate would have been 42, 46, and 49. Since the differences are less than 10% recalculation of normalized values and statistical treatments involving the blocks was judged to be unwarranted.

Compensation for blocking effects is less successful when there is lack of uniformity of cultural conditions within a block. The within-block between-tray differences can be readily evaluated by referring to Figure 2 and Table 5. Most tests show good reproducibility for controls. However, at least four blocks (B16, B17, B7 and B8) show significant spread in these composite median top growth values.

Interspecies effects are well demonstrated by reference to Table 1. For block B16 growth responses for sugar beet, mustard, and rye grass in the second control are roughly 60% of the responses in the first control. Millet response is zero in the second control and near normal in the first control. Could this have ben caused by a disease specific to millet, bad seed, or cultural conditions? A similar case is the response of rye grass in the controls for block B18.

It is thus possible to demonstrate two types of biasing effects using data from replicate control tests. Other effects are probable but not demonstrable with available data. The most important of these possible biasing effects is the possibility of fungal disease in only a portion of the test block. The result of such a biasing effect is that some test trays may show poor growth responses not because phytotoxins were originally present in the soil but because of a nonuniform pathogenic infection or nonuniform cultural conditions. This might be particularly true when test soils might, for instance, have markedly different water retention characteristics than the control soils composed of greenhouse compost. What might constitute serious over- or under-watering for test samples might cause no bad effect on better soils like greenhouse compost. The practical consequence is that if biasing occurs for samples from a given section at RMA which are included in the same block it will not be possible to distinguish this biasing or blocking effect from a phytotoxic effect. If, on the other hand, core samples from each section are randomly distributed between blocks, any blocking effects would be randomly distributed throughout many sections and would not bias results for a major part of any given section. In fact, the blocking effect would stand out as an anomaly not likely to be due to the presence of a phytotoxin.

4. Secondary Tests

Secondary tests were instituted to compensate for two possible poor soil factors (crusting and nutrient deficiency) which could be confused with phytotoxin effects. The modifications consisted of a sand covering and use of fertilizer. There seem to be no conditions under which one would expect a secondary test to produce plant growth responses less than responses in the corresponding primary test. Comparison of primary and secondary test results provides a good opportunity to estimate the frequency of occurence of erratic responses due to factors other than the presence of phytotoxins.

Criteria for judging the significance of secondary tests are: (1) if a secondary response is superior to a primary response, this could be due to correction of crusting conditions, correction of nutrient deficiencies or random effects; (2) if a secondary response is inferior to a primary response, this could be due only to a random effect; and (3) if both the secondary and primary tests produce a very poor response it is likely that a phytotoxin is present.

5. Comparison of Primary and Secondary Tests

The first step in the comparison of primary and secondary tests is to quantitatively describe average effects and ranges for the effects. A two-way analysis of variance[24] for all samples tested in secondary tests is given in Table 6. Normalized responses are used. In primary tests the average responses (Primary Means) were approximately 40 to 60% of the respective values for controls. In secondary tests the average responses were significantly higher. The average improvement in secondary tests was in the range of 21 to 44 units. On the average it seems that poor results in primary tests were due in major part to nutrient deficiencies or crusting which was alleviated in the secondary tests.

Confidence limits on mean difference values (Table 6) provide a good indication of the scatter in the effects of the secondary tests. For example, for sugar beets the 95% confidence limits on values of the difference between secondary and primary test reponses are -62 to 144 units. Thus, for any single pair of tests the addition of fertilizer and sand could result in a decrease in apparent plant vigor or an increase. The corresponding 95% confidence limits on the mean difference are 28 and 50 units. Thus, on the average, fertilizer and sand are beneficial to plant growth. A significant number of samples seem to have nutrient deficiencies or are prone to crusting. However, the wide confidence interval for the effects of secondary tests indicates that within the test samples there are some uncontrolled factors causing large random effects some of which could (in cases where secondary tests were not performed) cause effects similar to those of phytotoxins.

Individual values of secondary test responses relative to primary test responses can be analyzed to assess the range of apparent effects caused by the use of fertilizer and sand. In Table 7, test effects are listed individually for all secondary test data on sugar beet in the order of tests as given in Tables B16-B20 of Appendix B. The first column indicates the difference between primary and secondary tests whereas the second column indicates the mean effect for both tests. Normalized primary and secondary responses can be back-calculated from these data. Thus, the first difference value, 62, and mean, 76, corresponds to (from Appendix B, Table B16) sample number 36-1880-4080-2, with a secondary response of 6.5 length = 107% of the control normalization value. The primary response (from Appendix B, Table B1) was 2.5 cm length = 45% of the control normalization value. The difference value is 107-45 = 62. The mean value is [(107 + 45)/2] = 76.

TABLE 6

COMPARISON OF PRIMARY AND SECONDARY TESTS OF MEAN TOP GROWTH (MTG)
- A TWO-WAY ANALYSIS OF VARIANCE

Statistic	Sugar Beet	Mustard	Millet	Rye Grass
Primary Mean	48.8	42.9	45.4	56.7
Secondary Mean	89.9	87.9	66.4	91.8
Mean Difference	41.1	44.3	21.0	35.1
F, treatment	63.6**	246.6**	176.1**	261.1**
F, replications	0.2	2.51**	0.4	1.74*
Standard Deviation of MTG values***	36.4	20.1	24.3	19.0
Standard Deviation of Differences	51.5	28.4	34.4	26.9
Standard Deviation of the Mean Difference	6.8	3.8	4.5	3.5
95% conf. lim. on difference	-62 to 144	-13 to 101	-48 to 90	-19 to 89
95% conf. lim. on mean difference	28 to 50	37 to 52	12 to 30	28 to 42

* Significant at the 95% confidence level.
** Significant at the 99% confidence level.
*** Computed from residual mean square.

The data of Table 7 are plotted in Figure 3. The significance of the secondary test effects can be deduced by considering the effects expected of phytotoxins, poor soil, and uncontrolled random variation. For tests with phytotoxins present, mean response values should be low, e.g., less than 25, and difference values should be near zero because fertilizer and sand should not be expected to effectively counteract a phytotoxin unless it is present at low, ineffective concentrations. There are four data points (out of a total of 58 secondary tests) which satisfy both criteria.

For tests with poor soils one would expect a significant difference value; e.g., 25 or greater, independent of the mean response. Forty-three data points meet this criterion.

For tests with significant uncontrolled random variation, data points could be anywhere on Figure 3. One could arbitrarily define the detectable uncontrolled random variation region to be that shown in Figure 3. This corresponds essentially to the region with difference values less than 25 (insignificant effect of sand and fertilizer) and mean responses above 25 (mild or no depression of growth response). There are 12 data points in this region. Only two could be called truly erratic. These two data points indicate that under some conditions and in some not well understood fashion, the addition of fertilizer and sand can be apparently toxic to plants. The other ten point could easily represent moderately poor to normal soils for which addition of sand and fertilizer do not improve growth responses.

It seems reasonable to conclude that test replication in the form of secondary tests is very helpful in differentiating between the effects of phytotoxins and poor soils. A reliable criterion seems to be that any sample with a mean response (mean of primary and secondary responses) of less than 25 and absolute difference values less than 25 may be considered to contain a phytotoxic substance. There is, of course, still the possibility that physical characteristics of the soil may be responsible for such a response but a qualified botanist would surely note this when examining the soil.

One may also conclude that the majority of samples subjected to secondary tests did not contain phytotoxic substances at toxic concentrations. Thus, soil at RMA (from those areas tested) is not especially fertile and in some areas phytotoxins are present.

6. Precision

The precision with which the bioassay tests [25] can detect phytotoxins is dependent on the type of tests performed (primary and/or secondary), the severity of the growth retardation, the uniqueness of abnormalities noted, test design factors such as compounding with blocking effects, and the patterns of response of plants for nearby core samples. Estimates of the precision attainable through the use of various criteria are presented in Table 8.

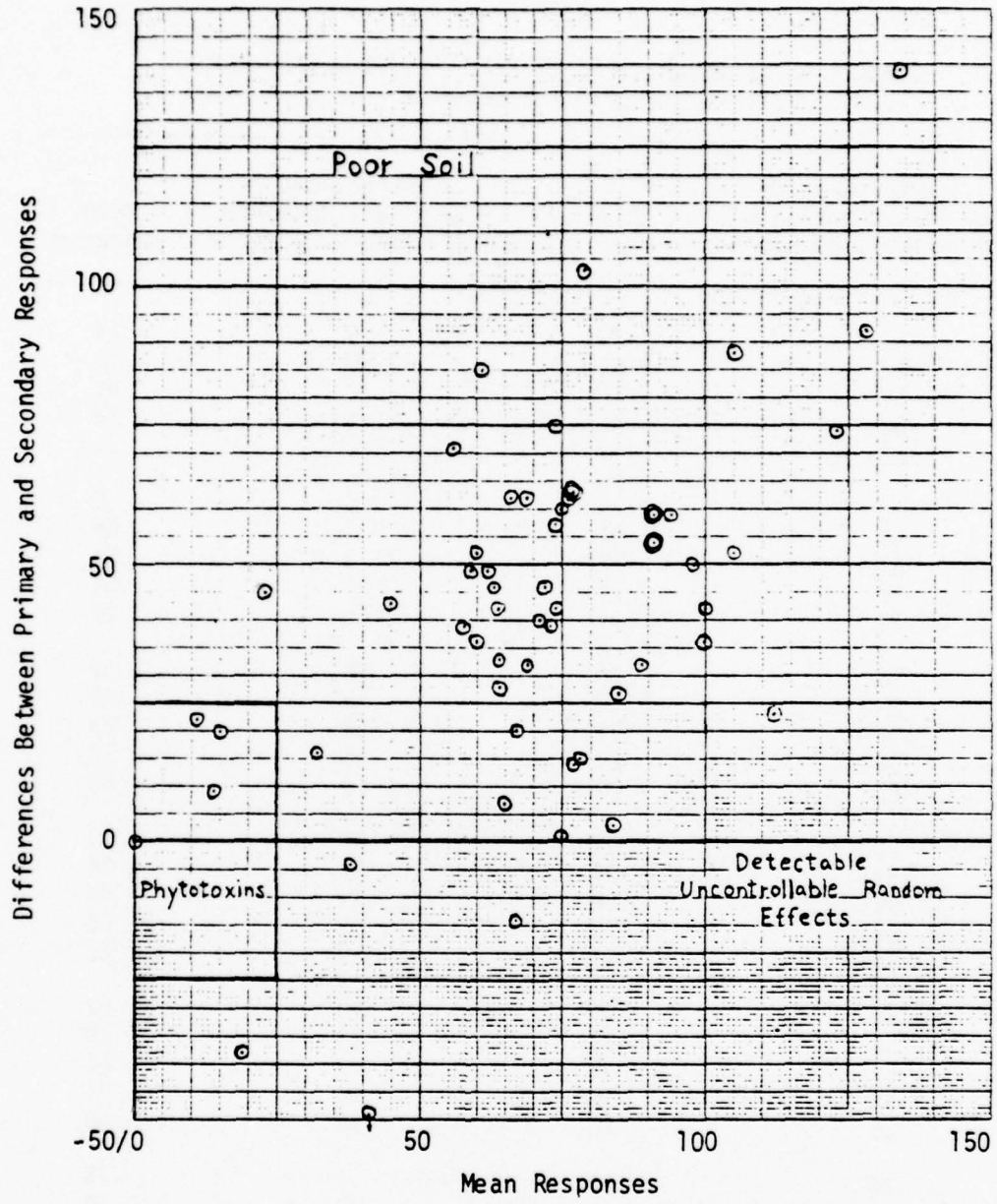

FIGURE 3

SECONDARY TEST EFFECTS FOR SUGAR BEETS

TABLE 7

SUMMARY OF SECONDARY TEST EFFECTS ON NORMALIZED MEAN TOP GROWTH VALUES FOR SUGAR BEETS

Difference (Secondary Response minus Primary Response)	Mean Response	Difference (Secondary Response minus Primary Response	Mean Response
62	76	9	14
28	64	20	15
57	74	7	65
-82	41	-4	38
32	89	22	11
103	79	0	0
54	91	33	64
63	77	3	84
59	94	27	85
75	74	46	63
36	100	16	32
23	112	43	45
74	123	45	23
54	91	46	72
63	77	52	60
50	98	62	69
139	134	42	64
92	128	39	58
60	75	71	56
59	91	49	59
42	100	20	67
52	105	-38	19
59	91	49	62
62	66	40	71
15	78	36	60
32	69	1	75
39	73	42	74
85	61	-14	67
88	105		
14	77		

* Original secondary test data were taken, in order, from Tables B16-B20 of Appendix B. Corresponding primary test data are taken from Tables B1-B15. Data normalized, by block, as described in the present report. These data are plotted in Figure 3.

TABLE 8

PRECISION OF PHYTOTOXICITY TESTS

No.	Criterion	Effects Producing Response or comment	Precision for Detecting Phytotoxins
1.	Primary test growth responses	Phytotoxins, nutrient deficiencies, crusting, blocking effects, random variation	low
2.	Primary and Secondary test growth responses	Phytotoxins, blocking effects, random variation	high
3.	Severe growth retardation	(Reduces the chance that retardation is simple random fluctuation)	--
4.	Unique abnormality	(Can in certain circumstances aid in differentiating pathogenic effects from the effects of phytotoxins	--
5.	Randomized design	(eliminates blocking effects)	--
6.	Data for contiguous cores	(Confirmatory evidence for widespread distribution of phytotoxins or poor soil)	moderate
7.	2,3, and 5 above	Phytotoxins, (random variation is a minor factor)	excellent

Definitive evidence for the existence of a phytotoxic substance in any sample requires a primary test, a secondary test, and severe growth retardation. For cases of significant but not severe growth retardation for several contiguous samples one could state that a phytotoxin (at marginally toxic concentrations) is present but only if the sample tests were performed in several test blocks in a random fashion. The occurrence of unique abnormalities characteristic of phytotoxin damage could be a criterion of high precision but will be unconvincing unless supporting references documenting the uniqueness of the abnormalities is provided. For the present series of tests growth retardations of less than 50% are not reliable indicators of phytotoxins. The effects of poor soil and random variations are of that order of magnitude.

III RESULTS AND DISCUSSION

Growth retardation an abnormalities were observed on plants grown on soil samples collected from several sections of Rocky Mountain Arsenal. Utilizing criteria similar to those of Table 8 it has been possible to definitively determine the occurrence of phytotoxins in soil samples from sections 26 and 36. Phytotoxic effects were absent or not definitively determined for soil samples from any other sections.

A cross reference guide of Boyce Thompson Institute sample number versus core location and depth segment has been prepared (Table 9). For samples showing good growth* a G (primary test) or g (secondary test) has been placed next to the sample number. For samples showing poor growth** a P (primary test) or p (secondary test) has been placed next to the sample number. Reference to Table 9 indicates several things: good growth occurs at all depths but more frequently near the surface; poor growth occurs infrequently in or is absent in samples from sections 5, 6, 8, 9, 23, 24 and 35; and poor growth occurs frequently in samples from sections 26 and 36.

A. AREAS WITH CONFIRMED PHYTOTOXIC CONDITIONS

There is little doubt that section 36 is contaminated with apparent phytotoxins. Data from Table 9 show poor growth in 21 primary tests and in 10 secondary tests. This poor growth occurs in samples from contiguous core segments. Areas of poor growth indicated in Table 9 correspond with areas of known gross contamination; i.e., the lime pits and Basin A regions [5]. An extensive discussion of growth retardation and abnormalities observed in test plants grow on soil samples from section 36 is included in the Boyce Thompson report [25]. Evidence for the presence is overwhelming. There is no need to argue, on a sample-by-sample basis, which results are due to phytotoxins, poor soil, and or blocking effects. Section 36 is contaminated with potent phytotoxins in well defined areas.

Data of Table 9 indicate poor growth for section 36 for core samples in 7 primary tests and 2 secondary tests. This poor growth is limited to samples adjacent to or downgradient from (northeast of) Basin F. These areas and core 26-3934-4922 are known to be contaminated [5]. It is curious that bioassays were not performed on samples from core 26-3934-4922. Growth responses and abnormalities are discussed briefly in the Boyce Thompson report [25]. It is clear that phytotoxins occur in soil samples from around the periphery of Basin F and downgradient therefrom.

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* Two or more species with greater than 80% of the control growth response.
** One or more species with less than 20% of the control growth response.

TABLE 9

CROSS REFERENCE GUIDE OF THE BOYCE THOMPSON SAMPLE NUMBER VERSUS CORE LOCATION AND DEPTH SEGMENT*

Coordinates			Depth Segments									
Section	E-W	N-S	1	2	3	4	5	6	7	8	9	10
5	1440	3200	485-G	536								
	1880	3640	488	489								
6	5400	3640	575	465								
	5400	4960	579G	577								
	5840	4520	461-G	463								
8	2403	5662	175	348	205	213	305					
	2432	1471	193-G	368	342	209						
	3142	1995	217-G	215	346	247	325					
	5101	5178	207-G	185	338							
	5579	5690	340-G	183-G	211	245						
9	1164	3572	149-G	433-G	139-G	133-G	135					
	1371	4731	431	394	131	127	376					
	2467	5762	392-G	390	372	374	354					
	4201	1299	400-GP	396	235	237	423					

TABLE 9 (Continued)

Coordinates			Depth Segments									
Section	E-W	N-S	1	2	3	4	5	6	7	8	9	10
9	4275	4774	356-G	403-G	401	398	419					
22	3200	2320	181-G	179	352	350	177					
	4960	1440	421-G	415	413	195	366					
	4960	3200	429	360	364	233	334-P					
23	1440	5840	545-G	547	599	535	533					
	2320	4080	406-G	99	145	102						
	2320	5840	549	441	517	439	437					
	3200	1440	435-G	151	386-G	388	412					
	3200	5840	519	537	659	499						
	4080	1440		669-G	665-G	523-G 524-G		667-G	633			
	4080	3200	100G	105	384	87	405					
	4080	4960	97G	107	147G	104	358					
	4080	5840	642	497 Twice								
	4960	1440	522-G	543-G	563	506	566 366	503				
	4960	2320					779					
	4960	5840	501-G	602-G	641							
	5840	1440	583-G	507-G	561	585	567 600	559	521			

TABLE 9 (Continued)

Coordinates			Depth Segments									
Section	E-W	N-S	1	2	3	4	5	6	7	8	9	10
23	5840	2320					773?-g					
	5840	3200				759	757					
	5840	4960	89 643	129 645	86	101						
	5840	5840	671-G	675	515							
24	1440	3200				689-g	693 691	724				
	1440	4080				695						
	1440	4960	661	603-G	601	565						
	1440	5840	285	479	481							
	2320	3200	425 417	203-G		239-P*						
	2320	4080				729	725-Pg					
	2320	4960	663-G	475	473	477						
	2320	5840	287	291								
	3200	1440	252	187	229	362	191					
	3200	4960	254-G	197-G								
	3200	5840	289-G	313								
	4080	3200	225G	227	370							
	4080	5840	295-G	293								

* Secondary tests indicate absence of phototoxicity.

TABLE 9 (Continued)

Coordinates			Depth Segments									
Section	E-W	N-S	1	2	3	4	5	6	7	8	9	10
24	4960	4960	539-G	541								
	4960	5840	427-G	199	231	223	201					
	5840	4960										
26	1880	1880	81-G	110	162	157	143					
	1880	5840	270-G 411-G	380	173		167					
	2320	3640	407-G 408 409-G	382	271	140-G						
	2760	3200	765	749	751	743	745	747	763-g	762	761-g	
	3200	3200	777-P*	718-P	682-P	727-P	775	719	699	717		
	3200	5840	591-G	607-G	605-g	589	587	527	528	531		
	3640	3200	739-p	735	737-g	715	741	713	703	731-g	716	
	3640	5840	639-GP	526-G	581	758-g	557	509	593	651		
	3934	4922										
	4080	3200	767	679-P*	769	704	771	677	701	705		
	4080	5400	451	569-G	445	443	571	471	469	467		
	4520	5400						755		733	753	
	4960	4960	96G	160-G	171	169G	115-G					721
	4960	5400						723	681	697-g	722	

*Secondary tests indicate absence of phytotoxicity.

TABLE 9 (Continued)

Coordinates			Depth Segments									
Section	E-W	N-S	1	2	3	4	5	6	7	8	9	10
26	5400	1880	114-G	117	92	119						
	5840	4520	551-G	553-G	555	494	491	495	617			
35	2760	4080	73	161-G	56-P	80	93					
	2760	5400	155-G	163	126	168-G	165					
	4960	2320	121	141	153							
	4960	4520	55	50	51	61-P	49					
	5400	3640	272-G	121	43 45							
36	1030	1440	17-g	378								
	1030	4080	25-g									
	1030	4520	28-g	62-G								
	1030	5840	76	69								
	1440	1030	513-g	653	511	647						
	1440	1440	629	635	611							
	1440	1880	649-G	615	637							
	1440	2320	631-G	655-G								
	1440	2760	595	597	657							
	1440	3200	30-g	79								
	1440	3640	9-Pg	7-g								

TABLE 9 (Continued)

Coordinates			Depth Segments									
Section	E-W	N-S	1	2	3	4	5	6	7	8	9	10
36	1440	4080	5-g	11-g								
	1440	4960		22-g								
	1440	5400	13-Gg	14-g								
	1880	1030	455	453	573	449						
	1880	1440	278-P	272-P								
	1880	1880	459-g	483	457-G	447						
	1880	2320	39-g	41-g								
	1880	2760	627-P	613								
	1880	3200	299	327								
	1880	3640	67-P	63-P								
	1880	4080	2-g	1-g								
	2320	1030	273	111								
	2320	1440	59-Pp	46-Pp								
	2320	1880	331-Pp	260-Pp	311-P	258-P						
	2320	2320		33-g								
	2320	3200	31-Pp									
	2320	3640	37-Pg	68-P								
	2320	4520		3-g								

TABLE 9 (Continued)

Coordinates			Depth Segments									
Section	E-W	N-S	1	2	3	4	5	6	7	8	9	10
36	2320	4960	276	329	309							
	2320	5840	21-g									
	2760	1030	619	621	609							
	2760	1440	317-Pp	303-p	315	301						
	2760	1880	113-P	74								
	2760	2320	32-gp	35-g								
	2760	5400	15-g	16-g								
	2760	5840	19-g	20-g								
	3200	1030	625-G	623-G	683	707-Pg						
	3200	1440	687-P	685	709	711-g						
	3200	4960	23-Gp	24-g								
	3200	5400	17-g	18-g								
	4080	4960	251-G	280	307	282	493					
	4520	2760	262	319	274	297						
	4960	4080	323-G	219	346	221						
	5400	4960	249	336	268	321	266					
	5840	2760	243-G	241	264	283						

TABLE 9 (Continued) Errors Noted in Original Report Together with Assumed Corrections, if Any

Coordinates			Depth Segments							Assumed Correct Coordinates		
Section	E-W	N-S	1	2	3	4	5	6	7			
25	4960	2320	121-G							35	4960	2320
36	1030	1880		75						?		
36	5400	1880		117						26	5400	1880
23	3200	2320		179						22	3200	2320
36	4080	5400	451							26	4080	5400
24	1440	1440			505					?		
24	4520	5400						696				

B. AREAS WITH NO CONFIRMED PHYTOTOXINS

No signs of phytotoxicity were observed in tests of soil samples from sections 5, 6 and 8.

Poor growth (Table 9) was observed in primary tests for one sample from section 9. A secondary test was not performed for this sample. On the basis of Table 8 criteria one must conclude that this could well be a case of poor soil. There is, in fact, no compelling reason to believe that phytotoxins were present. Since no other samples from this section showed severe growth retardation one would be inclined to discount the probability of the occurenc of phytotoxins in section 9 samples. If a definitive determination is required, a secondary test must be performed.

Growth responses for section 22 samples were analagous to those for section 9. Similarly, there is no compelling evidence to indicate the presence of a phytotoxic substance and if a definitive determination is required, a secondary test must be performed.

No signs of phytotoxicity were observed in samples from section 23.

Two samples from section 24 showed poor growth responses in primary tests (Table 9). However, secondary tests of these samples (Table 9) indicate that these respones were due to poor soils.

Two samples from section 35 showed poor growth in primary tests (Table 9). Both of the samples were tested in block B3. "... Obvious stunting of rye grass and millet resembled effects produced by herbicides effective against grasses "[25]. In the absence of secondary tests; with possible blocking effects; without similar results from adjacent cores; and without a detailed description of or reference to herbicide-like symptoms, one is forced to question the occurrence of phytotoxins in soil samples from section 35. Phytotoxins may well be present but their presence has not been conclusively demonstrated.

Conclusions regarding the presence or absence of phytotoxins are presented in Table 10.

TABLE 10

SUMMARY OF OBSERVED PHYTOTOXIN DISTRIBUTIONS AT RMA

Section	Area	Growth Retardation	Probable Cause	Presence of Phytotoxins Conclusively Demonstrated?
5	--	no	--	no
6	--	no	--	no
8	--	no	--	no
9	--	yes	poor soil ?	no
22	--	yes	poor soil ?	no
23	--	no	--	no
24	--	yes	poor soil ?	no
26	basin F region	yes	phytotoxins	yes
35	scattered	yes	poor soil or phytotoxins	no
36	lime pits and basin A	yes	phytotoxins	yes

IV SUMMARY AND RECOMMENDATIONS

Phytotoxicity tests of soil samples from RMA show that, generally, phytotoxins appear to be absent (or below toxic concentrations), except in section 26 near Basin F and in section 36 near the lime pits and Basin A (See Table 10). Growth retardation in primary tests of soils from other sections appears to be related to poor soil.

The OTSG coring program involved a very low density of cores in most sections of the arsenal. It was thus an initial effort to delineate the extent of contamination in known areas and to obtain background levels of pollutant in the areas of the arsenal thought to be unpolluted. It thus seems likely that the lack of completely definitive chemical analyses and bioassays for a few core samples does not detract from the general conclusions which have otherwise been obtained. For these reasons one may consider the Boyce Thompson phytotoxicity investigations to be complete. Further phytotoxicity testing of the OTSG samples is not warranted.

In a more intensive coring and analysis program such as the one now being conducted at RMA it may be advisable to consider refinements in the phytotoxicity test procedure. If phytotoxicity tests are performed, it would be beneficial to utilize a randomized block design and to consider an improved growth test in which physical factors affecting growth are minimized. It might, for instance, be beneficial to mix sand or other soil amendments with the test soil prior to testing. Use of fertilizer was an important improvement over the primary test procedure. It is important that tests be conducted by qualified investigators (such as Boyce Thompson personnel) who can diagnose and describe pathological signs in plants.

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APPENDIX A (25)

PHYTOTOXICITY DATA

Data in Appendix A are the emergence ratings, growth ratings, and other notes on growth and development of the indicator plants growing in soils from RMA. Data are visual indications of indicator plant development on a relative scale of 1 to 10 as compared with control plants growing in greenhouse compost and include height, color, and fullness of leaves. Observations were recorded weekly for three weeks following planting.

In some instances, the soil's physical conditions or plant diseases prevented normal indicator plant growth and development. Where these conditions were observed, identifying notes so indicate.

Useful symptoms for identifying phytotoxicity include stunting of top growth; chlorosis of leaves; necrosis of leaves, stems, and roots; and failure of seeds to germinate and grow. Less useful symptoms are yellowing and purple coloration of leaves and stems, as these may represent nutrient deficiencies. Differences of 20% in growth or emergence are probably not significant. Differences of 100% in growth or emergence are probably very significant.

Differences in response among indicator plants grown in the same test soil may reflect a difference in plant susceptibility to a particular phytotoxin. Certain plants may not be sensitive to specific contaminants or may require higher concentrations of contaminants before phytotoxicity symptoms develop.

APPENDIX A

PHYTOTOXICITY

Table A-1. Results of primary test number 1 indicating phytotoxicity observed on test plants planted 2/10/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
1	36-1880-4080-2	1	0	0	0	0	0	0	0	0	
		2	10	6	6	7	4	4	8	8	
		3	10	8	6	7	5	5	8	9	A
2	36-1880-4080-1	1	0	0	0	0	0	0	0	0	
		2	0	0	0	0	0	0	0	0	
		3	0	0	0	5	0	0	0	5	A
3	36-2320-4520-2	1	0	0	0	0	0	0	0	0	
		2	0	2	1	1	0	1	1	2	
		3	10	9	4	8	5	3	3	4	A
5	36-1440-4080-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	9	8	9	
7	36-1440-3640-2	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	7	9	9	B
9	36-1440-3640-1	1	1	0	0	0	0	0	0	0	
		2	3	0	0	0	2	0	0	0	
		3	9	0	0	1	3	0	0	1	A

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
11	36-1440-4080-2	1	8	9	8	8	5	4	5	5	
		2	10	10	10	10	6	5	7[n]	7	
		3	10	10	10	10	6	5	6[n]	5	C
13	36-1440-5400-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	6[y]	7	10[y]	9	D
14	36-1440-5400-2	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	7	8	9[y]	9	D,E
15	36-2760-5400-1	1	9	10	10	10	5	5	5	5	
		2	10	10	10	10	7	8	10	10	
		3	10	10	10	10	2	6	8[y]	8	
16	36-2760-5400-2	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	G
17	36-3200-5400-1	1	5	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
18	36-3200-5400-2	1	5	10	10	10	3	6	10	8	
		2	7	10	10	10	4	9	10	9	
		3	7	10	10	10	5	6	10	9	
19	36-2760-5840-1	1	8	9	10	9	5	10	10	9	
		2	9	10	10	9	9	10	10	9	
		3	9	10	10	10	6[y]	6	9[y]	8	G

(continued)

Sample No:	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
20	36-2760-5480-2	1	8	10	10	10	3	3	9	10	
		2	10	10	10	10	5	5	10	10	
		3	10	10	10	10	4	5	9	8	
21	36-2320-5840-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	8	9	9y,p	10	E
22	36-1440-4960-2	1	6	9	9	10	4	8	9	10	
		2	10	10	10	10	6	9	10	10	
		3	10	10	10	10	6	7	9y,p	8	
23	36-3200-4960-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	9	10y	10	
24	36-3200-4960-2	1	9	9	10	10	4	5	9	9	
		2	10	10	10	10	6	8	10	10	
		3	10	10	10	10	5	5	8	9	E
Control A		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls. Superscripts indicate as follows: c = chlorosis, p = purple pigmentation, y = yellowing, n = necrosis and s = stunting.

[d] Notes: A - soil appeared clayey and wetting problems with the soil may have delayed or inhibited germination; B - leaf tip necrosis on ryegrass; C - a few millet plants showed leaf necrosis; D - yellowing of older leaves of millet may indicate nitrogen deficiency; E - pronounced purple pigmentation on stem and leaves of foxtail millet; F - possible "damping off" on sugar beet; G - leaf tip necrosis on millet and ryegrass.

Table A-2. Results of primary test number 2 indicating phytotoxicity observed on test plants planted 2/18/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
25	36-1030-4080-1	1	10	9	9	9	5	8	10	9	
		2	10	10	10	10	5	5	6	9	
		3	10	10	10	10	4	4	5[y]	6	
27	36-1050-1440-1	1	8	10	10	10	4	5	9	6	
		2	10	10	10	10	6	6	6	8	
		3	10	10	10	10	6	6	6[p]	8	
28	36-1030-4520-1	1	10	10	9	10	6	9	10	9	
		2	10	10	10	10	7	8	10	10	
		3	10	10	10	10	6	7[y]	7[y,p]	8	
30	36-1440-3200-1	1	9	9	8	9	8	10	10	9	
		2	10	10	8	10	9	9	10	10	
		3	10	10	8	10	5[y]	6[y]	8[y]	7	
31	36-2320-3220-1	1	5	9	2	2	3	5	2	2	
		2	9	9	2	3	3	3	1[c]	2	
		3	9	9	Dead	3	2[n]	2[c]	Dead	3	A
32	36-2760-2320-1	1	4	9	3	8	5	5	3	3	
		2	10	10	3	10	6	5	5	5	
		3	10	10	3	10	7	6	5	6	
33	36-2320-2320-2	1	8	10	10	10	4	6	6	6	
		2	10	10	10	10	4	4	4	6	
		3	10	10	10	10	4	4	4	7	
35	36-2760-2320-2	1	9	10	10	10	8	7	9	6	
		2	10	10	10	10	4	4	4	6	
		3	10	10	10	10	4	4	4[p,y]	5	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
37	36-2320-3640-1	1	0	0	1	4	0	0	1	3	
		2	0	1	1	9	0	1	1	6	
		3	1	1	1[n]	9	1	1	2[n]	6	A
39	36-1880-2320-1	1	10	10	10	10	8	10	10	7	
		2	10	10	10	10	9	8	9	10	
		3	10	10	10	10	6	6	5[y]	7	
41	36-1880-2320-2	1	10	10	10	10	5	6	9	6	
		2	10	10	10	10	5	6	6	6	
		3	10	10	10	10	5	5	5[n,y]	7	B
Control		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls. Superscripts indicate as follows: c = chlorosis, n = necrosis, p = purple pigmentation, s = stunting and y = yellowing.

[d] Notes: A - a few millet plants emerged but subsequently died; B - tip necrosis on leaves of millet plants.

Table A-3. Results of primary test number 3 indicating phytotoxicity observed on test plants planted 3/24/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
43	35-5400-3640-3	1	9	10	10	10	6	6	9	9	
		2	10	10	10	10	6	6	9	8	
		3	10	10	10	10	6	6	9	9	
45	35-5400-3640-4	1	9	9	10	10	6	6	9	8	
		2	9	10	10	10	5	6	10	9	
		3	10	10	10	10	6	6	9	9	
46	36-2320-1440-2	1	1	0	0	0	0	0	0	0	
		2	2	1	1	1	1	1	1	1	
		3	5	2	2	2	2	1[c]	1	1[c]	A
49	35-4960-4520-5	1	10	10	10	9	5	7	8	7	
		2	10	10	10	9	6	8	9	8	
		3	10	10	10	10	6	8	9[y]	8	
50	35-4960-4520-2	1	10	10	8	8	5	5	5[s]	4[s]	
		2	10	10	9	9	7	6	4[s]	3[s]	
		3	10	10	9	9	7	6	4[s,y]	3[s]	B
51	35-4960-4520-3	1	10	10	9	9	6	6	5[s]	7	
		2	10	10	9	9	6	6	5[s]	5[s]	
		3	10	10	9	9	6	6	5[s]	5[s]	B
55	35-4960-4520-1	1	10	10	10	10	9	9	10	10	
		2	10	10	10	10	8	9	10	10	
		3	10	10	10	10	8	9	10	10	
56	35-2760-4080-3	1	10	10	6	6	4	8	3[s]	4[s]	
		2	10	10	8	8	4	6	3[s]	3[s]	
		3	10	10	8	8	4	5	3[s]	3[s]	B

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
59	36-2320-1440-1	1	0	0	0	0	0	0	0	0	
		2	1	0	0	0	1	0	0	0	
		3	1	0	0	0	1	0	0	0	
61	35-4960-4520-4	1	10	10	8	7	6	6	2[s]	2[s]	
		2	10	10	8	7	6	6	2[s]	2[s]	
		3	10	10	8	7	6	6	2[s,c,y]	2[s]	B
62	36-1030-4520-2	1	10	10	10	10	8	8	9	8	
		2	10	10	10	10	5	6	10	8	
		3	10	10	10	10	5	5	9[y]	8	
63	36-1880-3640-2	1	4	0	0	0	3	0	0	0	
		2	9	1	0	1	5	1	0	1	
		3	10	6	3	9	6	2	1	5	
67	36-1880-3640-1	1	5	4	3	3	3	3	2	1	
		2	9	8	4	5	3	3[s]	2[n]	3[s]	
		3	10	8	4	5	4	3[s]	2[n]	3[s]	
68	36-2320-3640-2	1	10	9	1	5	4	5	1	3	
		2	10	9	1	9	5	5	0[n]	8	
		3	10	10	1	9	8	6	0[n]	8	
69	36-1030-5840-2	1	10	10	10	10	9	9	9	10	
		2	10	10	10	10	7	8	9	9	
		3	10	10	10	10	7	8	9[y]	9	
73	35-2760-4080-1	1	10	10	9	9	9	8	9	10	
		2	10	10	9	9	7	8	10	9	
		3	10	10	9	9	7	8	10[y]	9	
74	36-2760-1880-2	1	10	10	10	10	9	7	10	7	
		2	10	10	10	10	8	7	6[s]	4[s]	
		3	10	10	10	10	8	8	6[s,y]	4[s]	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
75	36-1030-1880-2	1	10	10	10	10	9	8	10	9	
		2	10	10	10	10	7	7	10	9	
		3	10	10	10	10	7	7	10	9	
76	36-1030-5840-1	1	10	10	10	10	8	8	10	9	
		2	10	10	10	10	6	8	10	9	
		3	10	10	10	10	6	8	10[y]	9	
79	36-1440-3200-2	1	10	10	10	10	8	8	8	9	
		2	10	10	10	10	8	8	9	9	
		3	10	10	10	10	8	8	9	9	
80	35-2760-4080-4	1	10	10	10	10	8	8	10	10	
		2	10	10	10	10	6	8	7[n]	10	
		3	10	10	10	10	6	8	7[n]	10	C,D
81	26-1880-1880-1	1	9	9	7	5	8	6	5	5	
		2	9	10	8	9	9	8	8	9	
		3	10	10	8	9	9	9	9	9	
Control A		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
Control B		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls. Superscripts indicate as follows: c = chlorosis, n = necrosis, p = purple pigmentation, s = stunting and y = yellowing.

[d] Notes: A - soil sample had distinct foreign odor; B - stunting of grasses resemble that produced by known herbicides; C - soil swelled when water was added; D - some tip necrosis on leaves of millet.

Table A-4. Results of primary test number 4 indicating phytotoxicity observed on test plants planted 3/31/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
86	23-5840-4960-3	1	4	10	8	9	5	8	6	8	
		2	9	10	9	10	7	8	9	8	
		3	10	10	10	10	7	8	8	8	A
87	23-4080-3200-4	1	3	10	6	4	2	5	5	4	
		2	9	10	10	9	6	7	9	5	
		3	10	10	10	10	6	7	9	5	
89	23-5840-4960-1	1	1	10	2	1	1	6	1	1	
		2	10	10	9	9	6	7	7	7	
		3	10	10	9	9	7	8	7	7	
92	26-5400-1880-3	1	4	10	8	6	8	8	3	5	
		2	10	10	9	9	8	8	9	8	
		3	10	10	10	10	6	8	9	8	
93	35-2760-4080-5	1	9	10	5	6	5	8	3	4	
		2	10	10	10	10	8	8	9	8	
		3	10	10	10	10	7	8	9	8	
96	26-4960-4960-1	1	9	10	9	9	9	10	9	9	
		2	10	10	9	9	10	10	10	9	
		3	10	10	9	10	10	10	10	9	
97	23-4080-4960-1	1	9	10	9	9	9	10	10	8	
		2	10	10	9	10	10	10	10	9	
		3	10	10	10	10	10	10	10	9	
99	23-2320-4080-2	1	5	10	5	8	5	9	5	6	
		2	9	10	9	10	7	9	9	9	
		3	9	10	9	10	7	9	9	9	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
100	23-4080-3200-1	1	10	10	1	9	9	10	2	7	
		2	10	10	1	10	10	10	2	10	
		3	10	10	4	10	10	10	8	10	
101	23-5840-4960-4	1	9	10	4	9	5	7	6	5	
		2	10	10	8	9	6	7	8	8	
		3	10	10	8	10	6	7	8	8	
102	23-2320-4080-4	1	9	9	9	8	6	9	9	9	
		2	10	10	9	10	7	9	9	8	
		3	10	10	10	10	7	8	8	8	
104	23-4080-4960-4	1	9	10	8	8	6	8	8	7	
		2	9	10	9	9	6	8	9	8	
		3	9	10	10	10	6	8	9	8	
105	23-4080-3200-2	1	9	10	9	9	6	8	8	7	
		2	10	10	10	9	8	9	9	8	
		3	10	10	10	10	7	9	9	8	
107	23-4080-4960-2	1	9	10	10	9	6	8	9	7	
		2	10	10	10	9	7	8	10	8	
		3	10	10	10	10	7	8	10	8	
110	23-1880-1880-2	1	1	8	2	2	1	5	3	4	
		2	10	10	9	9	8	8	9	7	
		3	10	10	9	10	8	8	9	7	
111	36-2320-1030-2	1	8	10	1	1	5	8	1	1	
		2	10	10	2	5	5	9	2[s]	2[s]	
		3	10	10	3	5	5	9	3[s]	4[s]	B
113	36-2760-1880-1	1	1	2	0	0	1	1	0	2	
		2	3	9	0	4	5[s]	5[s]	0	3[s]	
		3	7	9	1	4	5[s]	7	1[s]	3[s]	B

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
114	26-5400-1880-1	1	9	10	6	8	6	8	10	10	
		2	10	10	9	9	9	9	10	10	
		3	10	10	10	10	9	9	10	10	
115	26-4960-4960-5	1	5	9	10	10	3	6	8	7	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
117	26-5400-1880-2	1	10	9	10	9	8	9	8	6	
		2	10	10	10	10	9	9	9	8	
		3	10	10	10	10	9	8	9	8	
119	26-5400-1880-4	1	6	9	10	9	6	6	8	9	
		2	9	9	10	9	6	7	9	8	
		3	9	9	10	9	6	6	8	7	
121	35-4960-2320-1	1	9	10	8	9	9	9	8	9	
		2	9	10	9	9	9	9	9	9	
		3	9	10	9	9	9	9	9	9	
123	35-5400-3640-2	1	9	10	10	10	9	9	9	9	
		2	9	10	10	10	8	9	10	9	
		3	9	10	10	10	8	8	10	8	
126	35-2760-5400-3	1	9	10	8	8	8	8	9	8	
		2	10	10	10	10	8	8	9	9	
		3	10	10	10	10	8	8	9	9	
127	09-1371-4731-4	1	8	10	10	9	6	8	10	9	
		2	10	10	10	10	6	8	10	8	
		3	10	10	10	10	6	8	10	8	
Control A		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
Control B		1	8	10	10	10	8	10	9	10	
		2	10	10	10	10	9	10	10	10	
		3	10	10	10	10	10	10	10	10	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls. Superscripts indicate as follows: c = chlorosis, n = necrosis, p = purple pigmentation, s = stunting and y = yellowing.

[d] Notes: A - clayey soil; B - stunting of grasses resembles that produced by known herbicides.

Table A-5. Results of primary test number 5 indicating phytotoxicity observed on test plants planted 4/1/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
129	23-5840-4960-1	1	10	10	3	10	8	9	5	5	
		2	10	10	4	10	8	8	5	8	
		3	10	10	5	10	8	8	5	8	
131	09-1371-4731-3	1	10	10	10	10	6	8	10	10	
		2	10	10	10	10	7	8	10	8	
		3	10	10	10	10	6	8	10	7	
133	09-1164-3572-4	1	10	10	10	10	9	9	10	10	
		2	10	10	10	10	9	8	10	9	
		3	10	10	10	10	8	8	10	8	
135	09-1164-3572-5	1	10	10	10	9	6	8	9	9	
		2	10	10	10	9	6	8	9	9	
		3	10	10	10	9	6	8	8	8	
137	09-1164-3572-3	1	8	10	8	3	8	8	7	8	
		2	10	10	9	9	6	8	6	9	
		3	10	10	9	9	6	7	6	8	
140	26-2320-3640-4	1	10	10	8	10	8	8	8	8	
		2	10	10	10	10	8	8	9	8	
		3	10	10	10	10	8	8	9	8	
141	35-4960-2320-2	1	8	10	8	9	8	9	9	8	
		2	10	10	10	10	8	8	9	8	
		3	10	10	10	10	7	8	9	7	
143	26-1880-1880-5	1	6	10	8	9	6	8	5	5	
		2	10	10	10	10	6	8	6	6	
		3	10	10	10	10	6	8	7	8	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
145	23-2320-4080-3	1	9	10	8	9	9	8	8	8	
		2	10	10	10	10	7	8	9	8	
		3	10	10	10	10	7	8	9	8	
147	23-4080-4960-3	1	9	9	8	10	7	8	8	8	
		2	10	10	10	10	7	7	8	7	
		3	10	10	10	10	7	7	8	7	
149	09-1164-3572-1	1	9	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
151	23-3200-1440-2	1	3	9	3	0	3	8	3	0	
		2	9	10	10	10	8	9	9	7	
		3	9	10	10	10	8	9	9	7	
153	23-4960-2320-2	1	9	10	8	3	8	8	8	8	
		2	10	10	9	10	7	8	8	8	
		3	10	10	9	10	6	8	8	7	
155	35-2760-5400-1	1	10	10	4	10	10	10	5	10	
		2	10	10	8	10	10	10	8	10	
		3	10	10	8	10	10	10	9	10	
157	26-1880-1880-4	1	0	4	1	0	0	4	1	0	
		2	10	10	10	10	6	7	8	8	
		3	10	10	10	10	6	7	8	7	
160	26-4960-4960-2	1	9	10	9	10	8	10	5	6	
		2	10	10	9	10	8	10	10	9	
		3	10	10	9	10	8	9	9	8	
161	35-2760-4080-2	1	10	10	9	10	8	10	5	8	
		2	10	10	10	10	10	10	6	8	
		3	10	10	10	10	10	8	9	8	

(continued)

Sample No.	Site designation	Week No.	Emergence rating [a]				Growth rating [b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
162	26-1880-1880-3	1	9	10	8	8	5	10	5	5	
		2	10	10	10	10	6	8	8	8	
		3	10	10	10	10	6	8	8	8	
163	35-2760-5400-2	1	10	10	9	10	8	8	10	9	
		2	10	10	10	10	8	8	10	9	
		3	10	10	10	10	8	8	9	8	
165	35-2760-5400-5	1	5	10	7	6	5	9	10	7	
		2	10	10	10	10	7	8	10	8	
		3	10	10	10	10	7	8	10	8	
167	26-1880-5840-5	1	9	10	5	7	10	9	8	7	
		2	10	10	8	9	7	8	8	9	
		3	10	10	8	9	7	8	8	8	
168	35-2760-5400-4	1	8	10	9	10	8	9	8	8	
		2	10	10	10	10	8	9	9	8	
		3	10	10	10	10	8	8	9	8	
169	26-4960-4960-4	1	10	9	9	10	9	9	8	8	
		2	10	10	10	10	8	9	9	8	
		3	10	10	10	10	8	8	9	8	
171	26-4960-4960-3	1	10	10	10	10	8	9	9	8	
		2	10	10	10	10	8	9	10	9	
		3	10	10	10	10	8	8	10	8	
173	26-1880-5840-3	1	9	10	10	10	10	9	10	8	
		2	10	10	10	10	8	8	10	8	
		3	10	10	10	10	8	7	9	8	
Control A		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
Control B		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls.

Table A-6. Results of primary test number 6 indicating phytotoxicity observed on test plants planted 5/5/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating [a]				Growth rating [b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
175	08-2403-5662-1	1	10	10	8	10	9	9	8	9	
		2	10	10	8	10	9	9	8	9	
		3	10	10	9	10	9	9	7	8	
177	22-3200-2320-5	1	10	10	10	10	7	8	8	8	
		2	10	10	10	10	7	8	8	8	
		3	10	10	10	10	7	8	9	8	
179	23-3200-2320-2	1	10	10	9	10	8	9	8	9	
		2	10	10	10	10	9	9	8	9	
		3	10	10	10	10	9	9	9	9	
181	22-3200-2320-1	1	10	10	9	10	9	9	9	10	
		2	10	10	9	10	9	9	9	10	
		3	10	10	10	10	9	9	9	10	
183	08-5579-5690-2	1	9	10	10	10	9	9	9	9	
		2	10	10	10	10	9	9	9	9	
		3	10	10	10	10	9	9	9	9	
185	08-5101-5178-2	1	10	10	10	10	8	8	8	8	
		2	10	10	10	10	8	8	8	9	
		3	10	10	10	10	9	8	9	9	
187	24-3200-1440-2	1	10	10	9	10	8	8	6	6	
		2	10	10	10	10	9	9	8	8	
		3	10	10	10	10	9	9	9	9	
189	24-2320-3200-5	1	10	10	10	10	8	8	9	9	
		2	10	10	10	10	8	8	9	9	
		3	10	10	10	10	8	8	9	9	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
191	24-3200-1440-5	1	10	10	9	10	8	8	9	9	
		2	10	10	9	10	8	8	8	9	
		3	10	10	9	10	8	8	8	9	
193	08-2432-1471-1	1	10	10	10	10	9	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
195	22-4960-1440-4	1	10	10	9	10	7	8	8	8	
		2	10	10	10	10	7	9	8	9	
		3	10	10	10	10	7	8	8	8	
197	24-3200-4960-2	1	9	10	7	10	8	9	7	8	
		2	10	10	8	10	8	10	8	10	
		3	10	10	10	10	9	10	9	9	
199	24-4960-5840-2	1	10	10	10	10	8	8	8	8	
		2	10	10	10	10	8	8	9	9	
		3	10	10	10	10	8	8	9	9	
201	24-4960-5840-5	1	10	10	8	8	8	9	8	8	
		2	10	10	8	8	8	8	8	8	
		3	10	10	10	8	8	8	8	8	
203	24-2320-3200-2	1	9	10	8	9	8	9	8	8	
		2	10	10	8	9	9	9	8	9	
		3	10	10	8	9	10	10	9	9	
205	08-2403-5662-3	1	6	10	10	10	8	8	8	8	
		2	7	10	10	10	7	8	8	8	
		3	8	10	10	10	7	8	8	8	
207	08-5101-5178-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
209	08-2432-1471-4	1	10	10	10	10	8	8	10	8	
		2	10	10	10	10	8	9	10	9	
		3	10	10	10	10	8	9	10	9	
211	08-5579-5690-3	1	10	10	10	10	8	8	8	8	
		2	10	10	10	10	9	8	9	9	
		3	10	10	10	10	9	9	9	9	
213	08-2403-5662-4	1	10	10	9	10	8	8	8	8	
		2	10	10	10	10	8	8	8	9	
		3	10	10	10	10	8	8	8	9	
215	08-3142-1995-2	1	10	10	8	10	8	8	9	9	
		2	10	10	8	10	9	8	9	9	
		3	10	10	8	10	9	8	8	9	
217	08-3142-1995-1	1	10	10	8	10	8	9	9	10	
		2	10	10	10	10	9	9	9	10	
		3	10	10	10	10	9	9	9	10	
219	36-4960-4080-2	1	10	10	10	10	8	9	8	9	
		2	10	10	10	10	8	9	8	9	
		3	10	10	10	10	9	9	9	9	
221	36-4960-4080-4	1	10	10	10	10	8	9	8	8	
		2	10	10	10	10	8	9	8	8	
		3	10	10	10	10	8	9	9	8	
223	24-4960-5840-4	1	10	10	10	9	7	9	9	7	
		2	10	10	10	10	7	9	7	8	
		3	10	10	10	10	8	8	8	8	
225	24-4080-3200-1	1	10	10	5	10	10	10	10	9	
		2	10	10	5	10	10	10	10	10	
		3	10	10	5	10	10	10	10	10	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
227	24-4080-3200-2	1	10	10	10	10	8	8	8	8	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	8	9	8	8	
229	24-3200-1440-3	1	10	10	10	10	8	8	7	7	
		2	10	10	10	10	8	8	7	7	
		3	10	10	10	10	8	8	8	8	
231	24-4960-5840-3	1	9	10	9	9	7	8	9	7	
		2	10	10	10	10	7	8	8	8	
		3	10	10	10	10	7	7	8	8	
233	22-4960-3200-4	1	10	10	10	10	7	7	8	8	
		2	10	10	10	10	7	7	8	8	
		3	10	10	10	10	7	8	8	8	
235	09-4201-1299-3	1	10	10	10	10	8	8	9	8	
		2	10	10	10	10	8	8	9	8	
		3	10	10	10	10	8	9	9	9	
237	09-4201-1299-4	1	10	10	10	10	7	7	7	7	
		2	10	10	10	10	7	8	9	9	
		3	10	10	10	10	7	8	8	9	
239	24-2320-3200-3	1	4	0	0	0	2	0	0	0	
		2	9	0	0	2	3	0	0	5	
		3	10	0	0	10	5	0	0	5	
Control A		1	9	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
Control B		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls.

Table A-7. Results of primary test number 7 indicating phytotoxicity observed on test plants planted 5/13/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
241	36-5840-2760-2	1	10	10	10	10	9	9	10	10	
		2	10	10	10	10	9	9	10	10	
		3	10	10	10	10	9	9	9	9	
243	36-5840-2760-1	1	10	10	3	9	10	10	6	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
245	08-5579-5690-4	1	9	10	10	10	7	9	9	10	
		2	10	10	10	10	7	8	9	10	
		3	10	10	10	10	8	8	9	10	
247	08-3142-1995-4	1	10	10	10	9	8	9	8	8	
		2	10	10	10	10	7	8	10	10	
		3	10	10	10	10	7	8	10	10	
249	36-5400-4960-1	1	10	10	10	10	10	8	10	10	
		2	10	10	10	10	8	9	10	10	
		3	10	10	10	10	9	9	10	10	
251	36-4080-4960-1	1	10	10	10	10	9	10	8	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
252	24-3200-1440-1	1	10	10	10	10	8	10	8	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
254	24-3200-4960-1	1	10	10	10	10	8	10	8	8	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
256	36-2320-4960-4	1	8	9	9	10	6	7	7	7	
		2	10	10	10	9	7	6	6	8	
		3	10	10	10	10	7	6	6	8	
258	36-2320-1880-4	1	9	9	9	9	6	8	4s	4s	
		2	10	10	8	9	5	7	4s	4s	
		3	10	10	8	9	5	7	3s	4s	A
260	36-2320-1880-2	1	0	0	0	0	0	0	0	0	
		2	0	0	0	0	0	0	0	0	
		3	0	0	0	0	0	0	0	0	
262	36-4520-2760-1	1	9	10	9	10	8	9	9	9	
		2	10	10	10	9	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
264	36-5840-2760-3	1	9	10	9	10	8	9	8	8	
		2	10	10	10	10	8	9	8	6	
		3	10	10	10	10	8	8	8	8	
266	36-5400-4960-5	1	10	10	10	10	8	10	8	7	
		2	10	10	10	10	7	8	8	6	
		3	10	10	10	10	7	8	8	7	
268	36-5400-4960-3	1	10	10	10	10	8	9	8	8	
		2	10	10	10	10	7	8	8	9	
		3	10	10	10	10	7	8	8	9	
270	26-1880-5840-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
271	26-2320-3640-3	1	9	10	9	10	7	8	8	9	
		2	10	10	10	10	8	8	8	9	
		3	10	10	10	10	7	7	8	8	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
272	35-5400-3640-1	1	10	10	10	9	10	10	10	9	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
273	36-2320-1030-1	1	9	10	2	8	6	9	3[s]	5[s]	
		2	10	10	3	6	9	9	4[s]	3[s]	
		3	10	10	3	6	9	9	4[s]	3[s]	
274	36-4520-2760-3	1	10	10	10	9	6	8	5	6	
		2	10	10	10	10	8	8	8	9	
		3	10	10	10	10	7	8	8	8	
276	36-2320-4900-1	1	1	8	6	6	1[s]	5	4	4	
		2	5	8	8	8	3[s]	5	5	5	
		3	5	8	8	8	3[s]	3[s,y]	4	5	
277	36-1880-1440-2	1	6	9	0	0	4[s]	8	0	0	
		2	10	10	1	1	4[s]	6[s]	1[s]	1[s]	
		3	10	10	1	1	4[s]	4[s]	1[s]	1[s]	A
278	36-1880-1440-1	1	6	9	0	0	2	6	0	0	B
		2	10	10	1	1	4[s]	5[s]	2[s]	1[s]	
		3	10	10	3	2	4[s]	5[s]	2[s]	1[s]	A
280	36-4080-4960-2	1	10	10	10	10	6	8	5	8	
		2	10	10	10	10	8	8	9	8	
		3	10	10	10	10	8	8	8	8	
282	36-4080-4960-4	1	10	10	10	10	8	8	6	8	
		2	10	10	10	10	8	8	8	9	
		3	10	10	10	10	8	8	8	8	
283	36-5840-2760-4	1	10	10	10	10	8	8	6	3	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	8	8	8	8	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
285	24-1440-5840-1	1	9	10	9	10	5	9	9	9	
		2	9	10	9	10	8	9	9	10	
		3	10	10	10	10	9	9	9	9	
287	24-2320-5840-1	1	3	10	9	10	4	8	4	4	
		2	10	10	10	10	5	8	6	7	
		3	10	10	10	10	8	8	8	8	
289	24-3200-5840-1	1	10	10	10	10	5	9	5	6	
		2	10	10	10	10	9	9	8	9	
		3	10	10	10	10	10	10	10	9	
291	24-2320-5840-2	1	10	10	8	9	8	8	3	3	
		2	10	10	8	9	8	8	4[s]	4[s]	
		3	10	10	9	9	7	7	4[s]	4[s]	
Control A		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
Control B		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls. Superscripts indicate as follows: c = chlorosis, n = necrosis, p = purple pigmentation, s = stunting and y = yellowing.

[d] Notes: A - Stunting of grasses resembles that produced by known herbicides. B - Hypocotyl swelling at base on all test species.

Table A-8. Results of primary test number 8 indicating phytotoxicity observed on test plants planted 5/19/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
293	24-4080-5840-2	1	5	9	7	8	10	10	9	10	
		2	9	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
295	24-4080-5840-1	1	8	10	9	9	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
297	36-4520-2760-4	1	3	10	8	3	5	8	8	6	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	8	8	8	9	
299	36-1880-3200-1	1	1	0	0	0	2	0	0	0	
		2	9	5	5	9	9	3[s]	4[s]	8	
		3	10	5	5	9	9	3[s]	5[s]	8	
301	36-2760-1440-4	1	8	9	8	8	8	8	5	6	
		2	10	10	10	10	6	6	6	6	
		3	10	10	10	10	7	7	7	8	
303	36-2760-1440-2	1	8	10	8	9	8	8	8	8	
		2	10	10	9	10	6	8	6	6	
		3	10	10	9	10	7	8	6[y]	6	
305	08-2403-5662-5	1	5	10	9	10	8	9	10	10	
		2	10	10	10	10	8	8	9	9	
		3	10	10	10	10	8	8	9	9	
307	36-4080-4960-3	1	8	10	9	10	8	9	8	8	
		2	10	10	10	10	8	9	8	8	
		3	10	10	10	10	8	9	8	9	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
309	36-2320-4960-3	1	0	2	0	3	0	1	0	0	
		2	10	10	5	10	6	4[s]	5[s]	8	
		3	10	10	5	10	7	5[s]	5[s]	8	
311	36-2320-1880-3	1	2	10	0	3	5	5	0	3	
		2	10	10	6	5	4[s]	5[s]	1[s]	3[s]	
		3	10	10	5	5	4[s]	5[s]	1[s]	3[s]	
313	24-3200-5840-2	1	1	10	2	2	1	5	0	2	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	8	8	8	8	
315	36-2760-1440-3	1	10	10	10	10	5	10	5	6	
		2	10	10	10	10	7	9	8	8	
		3	10	10	10	10	8	9	8	8	
317	36-2760-1440-1	1	10	10	8	10	5	8	8	8	
		2	10	10	10	10	6	8	7	8	
		3	10	10	10	10	7	8	7[y]	8	
319	36-4520-2760-2	1	9	10	0	8	5	8	0	3	
		2	9	10	0	8	10	10	0	3[s]	
		3	10	10	0	5	10	10	0	3[s]	
321	36-5400-4960-4	1	10	10	8	9	8	8	5	3	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	8	8	8	8	
323	36-4960-4080-1	1	10	8	9	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
325	08-3142-1995-5	1	8	10	8	10	5	8	8	6	
		2	10	10	10	10	7	8	P	8	
		3	10	10	10	10	8	8	8	8	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
327	36-1880-3200-2	1	1	4	2	3	2	4	4	4	
		2	10	9	4	9	8	6	5	8	
		3	10	10	8	10	8	8	6	8	
329	36-2320-4960-2	1	1	3	0	3	3	4	0	5	
		2	8	6	6	8	7	7	5	8	
		3	9	8	7	9	8	8	6	9	
331	36-2320-1880-1	1	0	0	0	0	0	0	0	0	
		2	0	0	0	0	0	0	0	0	
		3	0	0	0	0	0	0	0	0	
334	22-4960-3200-5	1	9	10	8	8	4	8	4	5	
		2	10	10	8	8	7	8	2[s]	5[s]	
		3	10	10	8	8	8	8	3[s]	5[s]	
336	36-5400-4960-2	1	8	10	8	10	8	8	4	4	
		2	10	10	8	10	7	8	5	6	
		3	10	10	8	10	8	8	7	8	
338	08-5101-5178-3	1	10	10	10	10	8	8	8	5	
		2	10	10	10	10	8	8	8	7	
		3	10	10	10	10	8	8	8	8	
340	08-5579-5690-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
342	08-2432-1471-3	1	10	10	8	10	8	8	9	9	
		2	10	10	8	10	8	8	8	8	
		3	10	10	8	10	8	8	8	8	
344	08-3142-1995-3	1	9	9	10	9	5	8	8	8	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	9	9	8	9	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
346	36-4960-4080-3	1	9	10	10	10	8	7	8	9	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	8	8	8	8	
348	08-2403-5662 2	1	10	10	10	10	8	9	10	9	
		2	10	10	10	10	8	8	9	9	
		3	10	10	10	10	8	8	9	9	
350	22-2300-2320-4	1	10	10	10	10	8	8	10	9	
		2	10	10	10	10	9	9	9	8	
		3	10	10	10	10	9	9	9	9	
352	22-3200-2320-3	1	8	9	10	10	7	8	9	8	
		2	10	10	10	10	7	8	9	8	
		3	10	10	10	10	8	8	9	8	
Control A		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
Control B		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls. Superscripts indicate as follows: c = chlorosis, n = necrosis, p = purple pigmentation, s = stunting and y = yellowing.

Table A-9. Results of primary test number 9 indicating phytotoxicity observed on test plants planted 5/26/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
354	09-2467-5762-5	1	10	10	9	9	8	9	9	9	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	8	8	8	8	
356	09-4275-4774-1	1	10	10	10	10	8	9	9	9	
		2	10	10	10	10	9	9	9	9	
		3	10	10	10	10	9	9	9	9	
358	23-4080-4960-5	1	10	10	10	10	8	8	9	10	
		2	10	10	10	10	8	8	8	9	
		3	10	10	10	10	8	8	8	9	
360	22-4960-3200-2	1	10	10	10	10	8	8	8	8	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	8	8	8	8	
362	24-3200-1440-4	1	10	10	10	10	7	7	9	9	
		2	10	10	10	10	7	8	8	7	
		3	10	10	10	10	8	8	8	9	
364	22-4960-3200-3	1	10	10	10	10	7	8	7	8	
		2	10	10	10	10	8	8	7	9	
		3	10	10	10	10	8	8	7	9	
366	22-4960-1440-5	1	10	10	10	10	7	8	8	8	
		2	10	10	10	10	7	8	7	8	
		3	10	10	10	10	7	8	7	8	
368	08-2432-1471-2	1	10	10	10	10	8	8	8	9	
		2	10	10	10	10	8	8	8	9	
		3	10	10	10	10	8	8	8	9	

(continued)

Sample No.	Site designation	Week No.	Emergence rating [a]				Growth rating [b]				Notes [d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
370	24-4080-3200-3	1	10	10	8	10	8	8	8	9	
		2	10	10	9	10	8	8	8	8	
		3	10	10	9	10	8	8	8	8	
372	09-2467-5762-3	1	10	10	10	10	7	8	8	8	
		2	10	10	10	10	7	8	8	8	
		3	10	10	10	10	7	8	8	9	
374	09-2467-5762-4	1	10	10	10	10	8	8	8	9	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	8	8	8	8	
376	09-1371-4731-5	1	10	10	10	10	8	9	9	8	
		2	10	10	10	10	8	9	9	8	
		3	10	10	10	10	8	8	8	8	
378	36-1030-1440-2	1	10	10	9	9	6	8	5	5	
		2	10	10	9	9	7	8	5	3	
		3	10	10	9	9	7	8	5	3	
380	26-1880-5840-2	1	10	10	8	9	8	8	6	6	
		2	10	10	9	10	8	8	8	8	
		3	10	10	9	10	8	8	8	8	
382	26-2320-3640-2	1	10	10	10	10	9	9	9	10	
		2	10	10	10	10	9	9	9	10	
		3	10	10	10	10	9	9	9	10	
384	23-4080-3200-3	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	9	9	9	9	
		3	10	10	10	10	9	9	9	9	
386	23-3200-1440-3	1	10	10	10	10	9	9	9	9	
		2	10	10	10	10	9	9	9	9	
		3	10	10	10	10	9	9	9	9	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
388	23-3200-1440-4	1	10	10	10	10	7	8	8	8	
		2	10	10	10	10	7	8	8	8	
		3	10	10	10	10	7	8	8	8	
390	09-2467-5762-2	1	10	10	10	10	7	8	9	9	
		2	10	10	10	10	7	8	9	9	
		3	10	10	10	10	7	8	9	9	
392	09-2467-5762-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
394	09-1371-4731-2	1	10	10	7	10	7	8	7	9	
		2	10	10	8	10	7	8	7	9	
		3	10	10	8	10	8	8	8	9	
396	09-4201-1299-2	1	10	10	10	10	9	9	9	9	
		2	10	10	10	10	9	9	9	9	
		3	10	10	10	10	9	9	9	9	
398	09-4275-4774-4	1	10	10	10	10	8	8	9	9	
		2	10	10	10	10	8	8	9	9	
		3	10	10	10	10	8	8	8	8	
400	09-4201-1299-1	1	10	0	1	4	7	0	2	5	
		2	10	0	1	5	10	0	2	9	
		3	10	0	1	5	10	0	3	8	A
401	09-4275-4774-3	1	10	10	10	10	7	7	9	9	
		2	10	10	10	10	8	8	8	9	
		3	10	10	10	10	8	8	8	9	
403	09-4275-4774-2	1	10	10	8	10	8	8	9	9	
		2	10	10	9	10	8	8	9	9	
		3	10	10	9	10	8	8	9	9	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
405	23-4080-3205-5	1	10	10	10	10	8	8	9	8	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	8	8	8	8	
406	23-2320-4080-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
407	26-2320-3640-1	1	10	10	2	10	10	10	9	10	
		2	10	10	2	10	10	10	9	10	
		3	10	10	2	10	10	10	10	10	B
408	26-2320-3640-1	1	10	10	3	9	7	7	5	8	
		2	10	10	3	10	7	7	5	8	
		3	10	10	3	10	7	7	5	8	
409	26-2320-3640-1	1	10	10	8	9	7	7	7	7	
		2	10	10	9	9	7	7	7	7	
		3	10	10	9	9	7	7	7	7	B
411	26-1880-5840-1	1	10	10	10	10	8	8	8	8	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	8	8	8	8	
412	23-3200-1440-5	1	10	10	9	10	8	8	8	8	
		2	10	10	9	10	8	8	8	8	
		3	10	10	9	10	8	8	8	8	
413	22-4960-1440-3	1	10	10	10	10	8	8	8	8	
		2	10	10	10	10	8	8	8	9	
		3	10	10	10	10	8	8	8	9	
415	22-4960-1440-2	1	10	10	10	10	8	8	9	8	
		2	10	10	10	10	8	8	9	8	
		3	10	10	10	10	8	8	9	8	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
417	24-2320-3200-1	1	10	10	10	8	7	8	8	9	
		2	10	10	10	9	7	8	8	8	
		3	10	10	10	9	7	8	8	8	
419	09-4275-4774-5	1	10	10	10	10	7	8	9	9	
		2	10	10	10	10	7	8	9	9	
		3	10	10	10	10	7	8	9	9	
421	22-4960-1440-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
423	09-4201-1299-5	1	10	10	10	10	9	10	10	9	
		2	10	10	10	10	9	9	9	9	
		3	10	10	10	10	9	9	9	9	
425	24-2320-3200-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
427	24-4960-5840-1	1	10	10	8	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
429	22-4960-3200-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	9	9	9	9	
		3	10	10	10	10	9	9	9	9	
431	09-1371-4731-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	9	9	9	9	
		3	10	10	10	10	9	9	9	9	
433	09-1164-3572-2	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
435	23-3200-1440-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
Control A		1	10	10	9	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
Control B		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls. Superscripts indicate as follows: c = chlorosis, n = necrosis, p = purple pigmentation, s = stunting and y = yellowing.

[d] Note: A - only one millet plant; B - only 5 millet plants.

Table A-10. Results of primary test number 10 indicating phytotoxicity observed on test plants planted 7/20/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating				Growth rating				Notes
			Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
437	23-2320-5840-5	1	10	10	10	10	6	8	6	7	
		2	10	10	10	10	6	8	6	7	
		3	10	10	10	10	6	7	6	7	
439	23-2320-5840-4	1	10	10	10	10	5	6	6	7	
		2	10	10	10	10	5	6	6	7	
		3	10	10	10	10	5	6	6	7	
441	23-2320-5840-2	1	10	10	10	10	5	6	6	7	
		2	10	10	10	10	5	6	6	7	
		3	10	10	10	10	5	6	6	7	
443	26-4080-5400-4	1	9	10	9	10	7	8	6	7	
		2	9	10	10	10	6	7	7	7	
		3	9	10	10	10	6	7	7	7	
445	26-4080-5400-3	1	10	10	10	10	6	8	7	8	
		2	10	10	10	10	6	8	8	8	
		3	10	10	10	10	7	8	8	8	
447	36-1880-1880-4	1	8	10	10	10	5	6	4	7	
		2	10	10	10	10	5	6	4	7	
		3	10	10	10	10	6	6	4	9	
449	36-1880-1030-4	1	9	10	10	10	7	8	7	8	
		2	10	10	10	10	7	8	7	8	
		3	10	10	10	10	7	8	7	8	
451	36-4080-5400-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	9	9	9	9	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
453	36-1880-1030-2	1	10	10	10	9	10	10	10	9	
		2	10	10	10	10	10	10	10	9	
		3	10	10	10	10	9	9	9	9	
455	36-1880-1030-1	1	10	10	10	10	6	8	9	8	
		2	10	10	10	10	6	8	9	8	
		3	10	10	10	10	6	8	8	8	
457	36-1880-1880-3	1	10	10	10	10	9	9	10	10	
		2	10	10	10	10	9	9	10	10	
		3	10	10	10	10	9	9	10	10	
459	36-1880-1880-1	1	10	10	10	9	8	9	8	7	
		2	10	10	10	9	8	8	8	6[s]	
		3	10	10	10	9	9	9	8	6[s]	
461	06-5840-4520-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	9	10	10	
463	06-5840-4520-2	1	10	10	10	10	6	7	9	9	
		2	10	10	10	10	6	7	8	9	
		3	10	10	10	10	6	7	8	8	
465	06-5400-3640-2	1	10	10	10	10	7	8	8	9	
		2	10	10	10	10	7	8	7	8	
		3	10	10	10	10	7	7	7	8	
467	26-4080-5400-8	1	9	10	10	10	8	8	8	10	
		2	9	10	10	10	7	8	7	9	
		3	9	10	10	10	7	8	8	9	
469	26-4080-5400-7	1	9	10	10	9	6	7	8	9	
		2	9	10	10	9	7	7	7	9	
		3	9	10	10	10	7	7	7	9	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
471	26-4080-5400-6	1	10	10	10	10	7	7	9	9	
		2	10	10	10	10	7	7	8	8	
		3	10	10	10	10	7	7	8	8	
473	24-2320-4960-3	1	10	10	10	10	6	8	8	9	
		2	10	10	10	10	5	7	5	8	
		3	10	10	10	10	6	7	6	8	
475	24-2320-4960-2	1	9	10	10	10	7	8	8	8	
		2	10	10	10	10	5	6	6	7	
		3	10	10	10	10	6	7	7	8	
477	24-2320-4960-4	1	10	10	10	10	6	7	8	8	
		2	10	10	10	10	6	7	6	7	
		3	10	10	10	10	6	7	7	8	
479	24-1440-5840-2	1	4	10	10	9	4	5	5	5	
		2	6	10	10	9	5	7	7	7	
		3	9	10	10	10	5	7	6	6	
481	24-1440-5840-3	1	10	10	10	10	7	8	8	8	
		2	10	10	10	10	7	7	7	8	
		3	10	10	10	10	7	7	7	8	
483	36-1880-1880-2	1	10	10	10	10	9	9	10	10	
		2	10	10	10	10	9	9	10	10	
		3	10	10	10	10	8	9	9	10	
485	05-1440-3200-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
489	05-1880-3640-2	1	10	10	10	10	6	8	8	8	
		2	10	10	10	10	7	8	8	8	
		3	10	10	10	10	7	8	8	8	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
491	26-5840-4520-5	1	10	10	10	10	7	8	8	10	
		2	10	10	10	10	8	8	8	9	
		3	10	10	10	10	8	8	8	8	
493	36-4080-4960-5	1	10	10	10	10	8	10	9	10	
		2	10	10	10	10	8	9	9	10	
		3	10	10	10	10	8	9	9	10	
494	26-5840-4520-4	1	10	10	10	10	7	8	9	10	
		2	10	10	10	10	8	8	10	10	
		3	10	10	10	10	7	8	9	9	
495	26-5840-4520-6	1	10	10	10	10	5	5	6	6	
		2	10	10	10	10	5	6	6	7	
		3	10	10	10	10	7	6	6	7	
497	23-4080-5840-2	1	9	10	10	10	8	9	9	9	
		2	10	10	10	10	8	9	9	9	
		3	10	10	10	10	7	8	8	8	
Control A		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
Control B		1	9	10	10	10	9	10	10	10	
		2	10	10	10	10	9	9	10	10	
		3	10	10	10	10	10	10	10	10	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls. Superscripts indicate as follows: c = chlorosis, n = necrosis, p = purple pigmentation, s = stunting and y = yellowing.

Table A-11. Results of primary test number 11 indicating phytotoxicity observed on test plants planted 7/22/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
497	23-4080-5840-2	1	10	10	10	10	8	8	8	7	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	6	6	8	8	
499	23-3200-5840-4	1	9	10	10	4	5	5	6	4	
		2	9	10	10	10	6	7	7	8	
		3	10	10	10	10	6	7	7	8	
501	23-4960-5840-1	1	10	10	10	10	8	9	9	8	
		2	10	10	10	10	9	10	10	9	
		3	10	10	10	10	9	10	10	10	
503	23-4960-1440-6	1	10	10	10	10	7	8	8	8	
		2	10	10	10	10	7	8	7	8	
		3	10	10	10	10	7	7	7	9	
505	24-1440-1440-3	1	10	10	10	10	6	7	7	7	
		2	10	10	10	10	7	7	7	8	
		3	10	10	10	10	7	7	7	8	
506	23-4960-1440-4	1	10	10	10	10	6	7	8	6	
		2	10	10	10	10	7	8	8	8	
		3	10	10	10	10	7	8	8	8	
507	23-5840-1440-2	1	10	10	10	10	7	8	6	8	
		2	10	10	10	10	8	9	8	9	
		3	10	10	10	10	8	9	9	10	
509	26-3640-5840-6	1	10	10	10	10	8	8	9	10	
		2	10	10	10	10	8	8	9	9	
		3	10	10	10	10	7	8	8	8	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
511	36-1440-1030-3	1	10	10	10	10	6	8	8	8	
		2	10	10	10	10	7	8	8	8	
		3	10	10	10	10	7	7	8	8	
513	36-1440-1030-1	1	10	10	5	10	5	8	4	5	
		2	10	10	5	10	8	9	5	5	
		3	10	10	5	10	8	9	4[s]	5[s]	
515	23-5840-5840-4	1	10	10	10	10	6	7	7	7	
		2	10	10	10	10	7	8	8	9	
		3	10	10	10	10	7	8	8	9	
517	23-2320-5840-3	1	10	10	10	10	8	8	8	8	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	8	8	8	9	
519	23-3200-5840-1	1	10	10	10	10	7	8	8	8	
		2	10	10	10	10	9	9	8	9	
		3	10	10	10	10	8	8	8	9	
521	23-5840-1440-7	1	10	10	10	10	7	6	8	8	
		2	10	10	10	10	7	7	8	8	
		3	10	10	10	10	7	7	8	8	
522	23-4960-1440-1	1	10	10	10	10	9	9	9	9	
		2	10	10	10	10	9	9	9	9	
		3	10	10	10	10	9	9	7	10	A
523	23-4080-1440-1	1	10	10	10	10	10	10	10	9	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	9	10	10	
524	23-4080-1440-4	1	10	10	10	10	7	8	8	9	
		2	10	10	10	10	8	8	9	10	
		3	10	10	10	10	7	8	8	10	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
526	26-3640-5840-2	1	10	10	10	10	10	10	10	9	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
527	26-3200-5840-6	1	10	10	10	10	7	8	9	10	
		2	9	10	10	10	7	7	8	9	
		3	10	10	10	10	7	7	7	9	
529	26-3200-5840-7	1	10	10	10	10	9	9	9	9	
		2	10	10	10	10	9	9	9	9	
		3	10	10	10	10	9	9	9	9	
531	26-3200-5840-8	1	10	10	10	10	7	10	8	9	
		2	10	10	10	10	9	9	8	8	
		3	10	10	10	10	9	9	8	8	
533	23-1440-5840-5	1	10	10	10	10	7	9	8	9	
		2	10	10	10	10	8	8	8	9	
		3	10	10	10	10	8	8	7	9	
535	23-1440-5840-4	1	10	10	10	10	5	7	5	4	
		2	10	10	10	10	7	6	6	7	
		3	10	10	10	10	6	6	6	6	
536	05-1440-3200-2	1	10	10	10	10	8	8	9	9	
		2	10	10	10	10	9	9	8	8	
		3	10	10	10	10	9	9	8	8	
527	23-3200-5840-2	1	8	8	8	7	5	6	5	5	
		2	10	10	10	10	6	7	6	6	
		3	10	10	10	10	6	7	6	6	
539	24-4960-4960-1	1	9	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
541	24-4960-4960-2	1	10	10	10	10	8	8	9	9	
		2	10	10	10	10	8	9	8	9	
		3	10	10	10	10	8	8	8	9	
543	23-4960-1440-2	1	10	10	10	10	10	10	10	9	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	8[n]	9	A
545	23-1440-5840-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	7[n]	10	A
547	23-1440-5840-2	1	10	10	10	10	6	7	8	8	
		2	10	10	10	10	6	7	8	8	
		3	10	10	10	10	7	7	7	9	
549	23-2320-5840-1	1	7	10	10	5	8	7	7	7	
		2	7	10	10	10	8	8	7	8	
		3	9	10	10	10	8	8	7	8	
551	26-5840-4520-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
553	26-5840-4520-2	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	9	10	
555	26-5840-4520-3	1	10	10	10	10	9	9	9	9	
		2	10	10	10	10	9	9	8	9	
		3	10	10	10	10	9	8	9	9	
557	26-3640-5840-5	1	10	10	10	10	7	8	8	7	
		2	10	10	10	10	7	8	8	8	
		3	10	10	10	10	7	7	8	8	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
559	23-5840-1440-6	1	10	10	10	10	6	6	7	7	
		2	10	10	10	10	6	7	7	9	
		3	10	10	10	10	6	7	6	9	
561	23-5840-1440-3	1	9	10	10	10	7	9	8	8	
		2	9	10	10	10	7	9	8	9	
		3	9	10	10	10	7	8	7	8	
563	23-4960-1440-3	1	10	10	10	8	8	8	8	7	
		2	10	10	10	9	6	6	7	7	
		3	10	10	10	10	6	6	6	6	
565	24-1440-4960-4	1	10	10	10	10	7	8	8	8	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	8	8	8	8	
566	23-4960-1440-5	1	10	10	10	10	8	8	8	8	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	8	8	8	8	
567	23-5840-1440-5	1	10	10	10	10	6	8	7	8	
		2	10	10	10	10	7	8	7	8	
		3	10	10	10	10	7	7	7	8	
569	26-4080-5400-2	1	10	10	10	10	9	9	9	9	
		2	10	10	10	10	9	9	9	9	
		3	10	10	10	10	9	9	9	9	
573	36-1880-1030-3	1	10	10	10	9	5	5	6	5	
		2	10	10	10	9	6	6	5	7	
		3	10	10	10	10	5	5	4	6	
575	06-5400-3640-1	1	10	10	10	10	8	8	8	8	
		2	10	10	10	10	9	9	8	9	
		3	10	10	10	10	9	9	5n,y	8	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
577	06-5400-4960-2	1	10	10	10	10	8	8	8	8	
		2	10	10	10	10	9	9	9	9	
		3	10	10	10	10	8	8	8	9	
579	06-5400-4960-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	9	10	10	10	
581	26-3640-5840-3	1	10	10	10	10	8	10	9	9	
		2	10	10	10	10	8	9	9	9	
		3	10	10	10	10	8	8	8	8	
583	23-5840-1440-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
585	23-5840-1440-4	1	10	10	10	10	8	8	8	8	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	7	7	7	7	
587	26-3200-5840-5	1	9	9	10	10	6	7	8	9	
		2	9	9	10	10	7	8	8	9	
		3	9	9	10	10	8	8	8	9	
589	26-3200-5840-4	1	9	10	10	10	7	8	8	8	
		2	9	10	10	10	8	8	8	8	
		3	10	10	10	10	8	8	8	8	
591	26-3200-5840-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
593	26-3640-5840-7	1	10	10	10	10	9	8	8	9	
		2	10	10	10	10	8	8	8	9	
		3	10	10	10	10	8	8	8	9	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
595	36-1440-2760-1	1	10	10	10	10	8	8	9	9	
		2	10	10	10	10	8	8	9	9	
		3	10	10	10	10	8	8[n]	8	9	B
597	36-1440-2760-2	1	10	10	10	10	8	8	9	8	
		2	10	10	10	9	8	8	8	8	
		3	10	10	10	9	8	8	8	8	
599	23-1440-5840-3	1	9	10	10	10	7	7	8	8	
		2	9	10	10	10	7	7	8	8	
		3	9	10	10	10	8	8	8	8	
600	23-5840-5840-5	1	10	10	10	10	7	8	9	9	
		2	10	10	10	10	8	9	9	9	
		3	10	10	10	10	8	8	8	8	
601	24-1440-4960-3	1	10	10	10	10	6	8	7	8	
		2	10	10	10	10	7	8	8	8	
		3	10	10	10	10	7	8	7	8	
602	23-4960-5840-2	1	10	10	10	10	7	8	9	9	
		2	10	10	10	10	9	9	9	9	
		3	10	10	10	10	9	9	9	9	
603	24-1440-4960-2	1	10	10	10	10	9	9	9	9	
		2	10	10	10	10	9	9	9	9	
		3	10	10	10	10	9	9	9	9	
605	26-3200-5840-3	1	7	10	9	6	5	5	4	4	
		2	9	10	10	10	5	5	4	7	
		3	9	10	10	10	5	5	5	7	
607	26-3200-5840-2	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

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BIOLOGICAL TESTING OF ROCKY MOUNTAIN ARSENAL FOR PHYTOTOXIC SUB--ETC(U)
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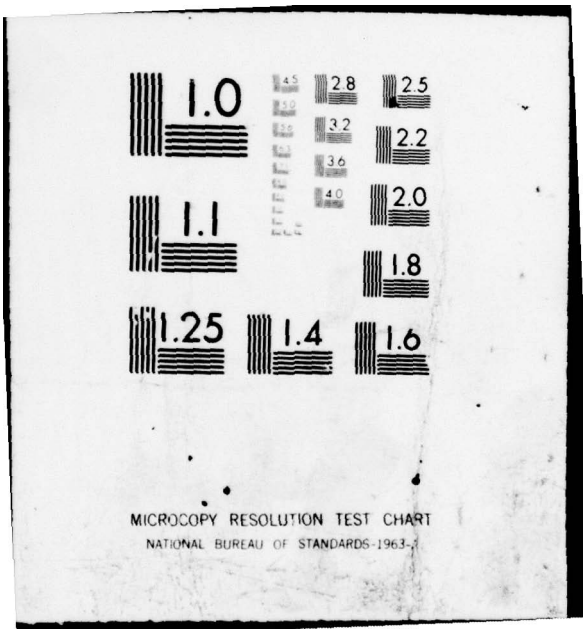
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[d]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
609	36-2760-1030-3	1	9	10	10	10	8	9	9	9	
		2	9	10	10	10	8	9	9	9	
		3	9	10	10	10	6	8	8	8	
Control A		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
Control B		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls. Superscripts indicate as follows: n = necrosis, s = stunting and y = yellowing.

[d] Notes: A - Leaf necrosis on millet could be caused by disease organism; B - necrosis on mustard likely due to "damping off" disease.

Table A-12. Results of primary test number I2 indicating phytotoxicity observed on test plants planted 7/28/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[c]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
611	36-1440-1440-3	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
613	36-1880-2760-2	1	10	10	8	5	10	10	6	6	
		2	10	10	10	8	8	8	6	6	
		3	10	10	10	8	8	7	5	5	
615	36-1440-1880-2	1	10	10	10	10	8	8	9	10	
		2	10	10	10	10	9	9	9	10	
		3	10	10	10	10	9	9	9	10	
617	26-5840-4520-7	1	10	10	10	10	8	8	9	9	
		2	10	10	10	10	8	8	8	9	
		3	10	10	10	10	8	9	8	9	
619	36-2760-1030-1	1	10	10	10	10	10	9	9	9	
		2	10	10	10	10	10	9	8	10	
		3	10	10	10	10	9	9	8	10	
621	36-2760-1030-2	1	10	10	10	10	7	7	8	8	
		2	10	10	10	10	7	7	8	8	
		3	10	10	10	10	6	7	8	8	
623	36-3200-1030-2	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
625	36-3200-1030-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[c]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
627	36-1880-2760-1	1	2	0	0	0	3	0	0	0	
		2	6	2	1	2	3	1	1	1	
		3	8	2	1	2	3	1	1	1	
629	36-1440-1440-1	1	10	10	8	10	10	10	8	9	
		2	10	10	8	10	10	6	8	8	
		3	10	10	8	10	10	6	8	8	A
631	36-1440-2320-1	1	9	10	10	10	10	10	10	10	
		2	10	10	10	10	10	6	9	10	
		3	10	10	10	10	10	7	9	10	A
633	23-4080-1440-7	1	10	10	10	10	8	8	8	9	
		2	10	10	10	10	8	8	8	9	
		3	10	10	10	10	8	8	8	9	
635	36-1440-1440-2	1	10	10	7	10	10	10	8	10	
		2	10	10	7	10	10	10	8	9	
		3	10	10	8	10	9	10	8	9	
637	36-1440-1880-3	1	10	10	10	10	8	8	8	9	
		2	10	10	10	10	8	8	8	9	
		3	10	10	10	10	8	8	8	9	
639	26-3640-5840-1	1	10	10	6	6	10	10	8	8	
		2	10	10	6	6	10	10	8	8	
		3	10	10	6	6	10	10	8	8	B
641	23-4960-5840-3	1	10	10	10	10	7	8	7	8	
		2	10	10	10	10	7	7	7	8	
		3	10	10	10	10	7	7	7	8	
642	23-4080-5840-1	1	9	10	9	8	8	8	8	7	
		2	10	10	10	9	10	10	9	9	
		3	10	10	10	9	10	10	9	9	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[c]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
643	24-5840-4960-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	9	9	
		3	10	10	10	10	10	10	9	9	
645	24-5840-4960-2	1	10	10	10	10	9	9	9	9	
		2	10	10	10	10	10	9	8	9	
		3	10	10	10	10	10	9	8	9	
647	36-1440-1030-4	1	10	10	10	10	9	9	9	9	
		2	10	10	10	10	8	9	8	9	
		3	10	10	10	10	8	9	8	9	
649	36-1440-1880-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
651	26-3640-5840-8	1	10	10	10	10	8	8	8	9	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	8	8	8	8	
653	36-1440-1030-2	1	10	10	10	10	8	8	8	8	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	8	9	6	7	
655	36-1440-2320-2	1	10	10	10	10	9	9	9	9	
		2	10	10	10	10	9	9	9	9	
		3	10	10	10	10	9	9	9	9	
657	36-1440-2760-3	1	10	10	10	10	8	8	8	8	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	8	8	8	9	
659	23-3200-5840-3	1	10	10	9	8	7	6	7	6	
		2	10	10	10	10	7	7	7	7	
		3	10	10	10	10	8	7	7	7	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[c]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
661	24-1440-4960-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
663	24-2320-4960-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
665	23-4080-1440-3	1	10	10	10	10	9	9	9	9	
		2	10	10	10	10	9	9	9	9	
		3	10	10	10	10	9	9	9	9	
667	23-4080-1440-6	1	10	10	10	10	9	9	9	10	
		2	10	10	10	10	9	9	9	10	
		3	10	10	10	10	9	9	9	10	
669	23-4080-1440-2	1	10	10	10	10	10	10	9	9	
		2	10	10	10	10	10	10	8	9	
		3	10	10	10	10	9	10	7y,n	9	c
671	23-5840-5840-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
673	23-5840-5840-3	1	10	10	10	10	7	8	8	7	
		2	10	10	10	10	7	8	8	8	
		3	10	10	10	10	7	8	8	8	
675	23-5840-5840-2	1	10	10	10	10	8	8	8	8	
		2	10	10	10	10	8	8	8	8	
		3	10	10	10	10	8	8	8	8	
571	26-4080-5400-5	1	8	10	6	10	6	8	6	8	
		2	10	10	6	10	6	8	6	8	
		3	10	10	10	10	7	8	6	8	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[c]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
Control A		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
Control B		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls. Superscripts indicate as follows: n = necrosis and y = yellowing.

[c] Notes: A - looks like "damping off" on mustard; B - "damping off" on sugar beet; C = tip necrosis on leaves of foxtail millet.

Table A-13. Results of primary test number 13 indicating phytotoxicity observed on test plants planted 8/26/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating [a]				Growth rating [b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
677	26-4080-3200-6	1	10	10	10	10	4	6	8	8	
		2	10	10	10	10	6	7	7	8	
		3	10	10	10	10	7	8	8	8	
679	26-4080-3200-2	1	0	0	1	1	0	0	2	1	
		2	4	2	2	2	2	1	2	5	
		3	4	2	2	2	2	1	2	5	
681	26-4960-5400-7	1	6	10	2	10	5	5	8	8	
		2	9	10	3	10	6	7	6	8	
		3	10	10	4	10	8	9	8	9	
682	26-3200-3200-3	1	0	0	0	0	0	0	0	0	
		2	0	0	0	0	0	0	0	0	
		3	0	0	0	0	0	0	0	0	
683	36-3200-1030-3	1	10	10	8	10	8	8	9	9	
		2	10	10	10	10	7	7	7	8	
		3	10	10	10	10	9	9	9	9	
685	36-3200-1440-2	1	10	10	8	10	6	6	8	8	
		2	10	10	10	10	5	5	7	7	
		3	10	10	10	10	8	8	8	8	
687	36-3200-1440-1	1	7	10	3	10	3	4	0	3	
		2	10	10	3	10	6	7	3	7	
		3	10	10	3	10	8	8	3	9	
689	24-1440-3200-4	1	4	10	1	4	4	6	2	3	
		2	4	10	6	10	6	7	3	7	
		3	4	10	6	10	7	9	5	9	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
691	24-1440-3200-5	1	10	10	8	10	5	5	8	7	
		2	10	10	10	10	5	5	6	7	
		3	10	10	10	10	7	7	7	8	
693	23-4960-2320-4	1	10	10	10	10	5	6	8	9	
		2	10	10	10	10	6	7	6	8	
		3	10	10	10	10	9	9	9	10	
695	24-1440-4080-4	1	10	10	5	10	5	5	6	7	
		2	10	10	10	10	6	7	5	7	
		3	10	10	10	10	7	8	7	8	
696	24-4520-5400-7	1	4	8	10	10	3	3	5	8	
		2	4	10	10	10	5	5	5	7	
		3	4	10	10	10	7	7	7	8	
697	26-4960-5400-8	1	3	10	9	1	4	5	7	1	
		2	10	10	1	10	4	5	3	7	
		3	10	10	9	10	7	7	3	9	
699	26-3200-3200-7	1	10	10	9	10	5	6	8	8	
		2	10	10	10	10	5	7	7	8	
		3	10	10	10	10	7	10	8	10	
701	26-4080-3200-7	1	7	8	5	4	5	5	2	2	
		2	10	10	10	10	5	6	4	7	
		3	10	10	10	10	7	10	7	10	
703	26-3640-3200-7	1	0	9	4	1	0	6	6	4	
		2	8	10	7	10	4	6	3	6	
		3	8	10	7	10	6	8	4	8	
704	26-4080-3200-4	1	2	9	9	9	2	5	7	5	
		2	8	10	8	10	4	6	6	6	
		3	8	10	9	10	6	7	7	10	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
705	26-4080-3200-8	1	4	10	9	4	3	3	5	3	
		2	10	10	8	10	5	5	5	6	
		3	10	10	10	10	8	8	8	10	
707	36-3200-1030-4	1	5	0	0	1	1	0	0	1	
		2	10	8	0	10	5	3	0	7	
		3	10	10	0	10	7	7	0	10	
709	36-3200-1440-3	1	3	10	9	1	3	8	8	2	
		2	4	10	9	2	4	7	7	7	
		3	6	10	9	3	7	8	8	7	
711	36-3200-1440-4	1	0	10	4	4	0	6	5	2	
		2	0	10	5	10	0	6	4	6	
		3	1	10	7	10	7	9	7	9	
713	26-3640-3200-6	1	8	10	10	10	5	5	6	8	
		2	8	10	10	10	5	6	6	7	
		3	10	10	10	10	7	7	7	9	
715	26-3640-3200-4	1	10	10	10	10	9	8	9	9	
		2	10	10	10	10	7	7	8	8	
		3	10	10	10	10	9	9	9	10	
716	26-3640-3200-9	1	10	7	8	10	5	8	9	7	
		2	10	10	10	10	6	7	7	7	
		3	10	10	10	10	9	9	9	9	
717	26-3200-3200-8	1	8	10	7	8	5	7	6	4	
		2	10	10	10	1	5	6	4	6	
		3	7	10	5	1	5	9	4	6	
718	26-3200-3200-2	1	4	10	8	0	2	5	5	0	
		2	8	10	8	0	3	5	4	0	
		3	8	10	8	0	3[y]	5[y]	4[y]	0[y]	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
719	26-3200-3200-6	1	9	10	10	10	5	5	9	8	
		2	10	10	10	10	5	5	7	8	
		3	10	10	10	10	7	7	10	10	
721	26-4960-5400-10	1	10	9	10	10	8	8	8	9	
		2	10	10	10	10	7	7	7	8	
		3	10	10	10	10	9	9	9	9	
722	26-4960-5400-9	1	10	10	10	10	5	8	6	6	
		2	10	10	10	10	6	7	7	7	
		3	10	10	10	10	6	9	9	9	
723	26-4960-5400-6	1	10	10	10	10	6	7	8	5	
		2	10	10	10	10	7	7	7	7	
		3	10	10	10	10	9	9	8	9	
724	24-1440-3200-6	1	10	10	10	5	7	8	9	6	
		2	10	10	10	10	7	8	8	7	
		3	10	10	10	10	9	9	9	9	
725	24-2320-4080-5	1	6	10	10	10	4	5	8	8	
		2	6	10	10	10	4	5	4	6	
		3	6	10	10	10	4	5	4	6[y]	
727	26-3200-3200-4	1	4	8	2	8	4	4	2	6	
		2	5	8	3	10	4	4	2	5	
		3	5	8	3	10	4[y]	4[y]	2[y]	5[y]	
729	24-2320-4080-4	1	10	10	10	10	6	6	9	9	
		2	10	10	10	10	5	6	6	8	
		3	10	10	10	10	7	7	7	9	
731	26-3640-3200-8	1	1	0	10	10	2	0	5	6	
		2	10	5	10	10	4	3	6	7	
		3	10	7	10	10	6	5	8	10	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
733	26-9520-5400-8	1	10	10	10	10	5	6	8	5	
		2	10	10	10	10	6	6	7	7	
		3	10	10	10	10	8	8	7	10	
735	26-3640-3200-2	1	10	10	6	10	6	5	8	8	
		2	10	10	7	10	7	6	7	7	
		3	10	10	10	10	9	9	9	9	
737	26-3640-3200-3	1	10	10	10	10	7	8	9	9	
		2	10	10	10	10	7	7	8	8	
		3	10	10	10	10	9	9	9	9	
739	26-3640-3200-1	1	4	0	6	10	4	0	4	5	
		2	4	0	6	10	6	1	2[n]	5[n]	
		3	4	0	Dead	6	6	0	Dead	5[n]	
741	26-3640-3200-5	1	10	10	10	10	7	8	9	9	
		2	10	10	10	10	7	8	8	8	
		3	10	10	10	10	9	9	9	9	
743	26-2760-3200-4	1	10	10	10	10	6	5	5	4	
		2	10	10	10	10	5	5	5	6	
		3	10	10	10	10	7	7	7	9	
745	26-2760-3200-5	1	10	10	10	10	6	5	8	8	
		2	10	10	10	10	5	6	7	7	
		3	10	10	10	10	7	7	9	9	
747	26-2760-3200-6	1	10	10	10	2	6	7	8	5	
		2	10	10	10	4	7	8	7	6	
		3	10	10	10	5	9	10	9	8	
749	26-2760-3200-2	1	10	10	10	10	6	9	9	9	
		2	10	10	10	10	8	9	9	9	
		3	10	10	10	10	10	10	10	10	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
751	26-2760-3200-3	1	10	10	10	10	5	5	8	8	
		2	10	10	10	10	5	6	6	7	
		3	10	10	10	10	7	7	7	9	
753	26-4520-5400-9	1	10	10	10	10	6	7	8	8	
		2	10	10	10	10	6	7	7	7	
		3	10	10	10	10	7	8	8	9	
755	26-4520-5400-6	1	4	8	1	4	3	4	1	4	
		2	10	10	2	10	4	6	3	5	
		3	10	10	6	10	7	8	5	9	
757	23-5840-3200-5	1	10	10	9	10	5	5	9	8	
		2	10	10	10	10	6	7	6	7	
		3	10	10	10	10	8	8	8	9	
758	26-3640-5840-4	1	10	10	9	10	5	5	4	6	
		2	10	10	9	10	5	5	4	6	
		3	10	10	10	10	7	8	6	8	
759	23-5840-3200-4	1	10	10	10	10	6	6	9	8	
		2	10	10	10	10	6	7	8	8	
		3	10	10	10	10	8	8	9	9	
761	26-2760-3200-9	1	4	4	2	0	3	4	1	0	
		2	5	10	3	0	6	7	5	0	
		3	9	10	5	1	7	7	5	1	
762	26-2760-3200-8	1	9	10	4	10	3	6	4	0	
		2	10	10	5	10	5	6	5	6	
		3	10	10	7	10	7	7	7	7	
763	26-2760-3200-7	1	4	10	2	3	3	4	1	4	
		2	10	10	3	10	5	6	4	6	
		3	10	10	3	10	7	8	6	9	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
765	26-2760-3200-1	1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
Control A		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
Control B		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls. Superscripts indicate as follows: n = necrosis and y = yellowing.

Table A-14. Results of primary test number 14 indicating phytotoxicity observed on test plants planted 8/27/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[c]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
767	26-4080-3200-1	1	5	6	8	3	4s	3s	4n	3	
		2	5	5	8	3	4s	3s	4n	3	
		3	7	5	8	3	5s	3s	4n	6	A
769	26-4080-3200-3	1	8	10	10	10	8	8	9	9	
		2	8	10	10	10	7	8	9	9	
		3	10	10	10	10	8	9	9	10	
771	26-4080-3200-5	1	10	10	10	10	6	8	8	8	
		2	10	10	10	10	6	8	8	8	
		3	10	10	10	10	6	8	8	8	
773	23-5840-2320-5	1	10	10	10	1	6	8	8	2	
		2	10	10	10	1	6	8	8	2	
		3	10	10	10	1	7	9	9	2	
775	26-3200-3200-5	1	6	10	2	9	8	8	2	9	
		2	6	10	2	9	6	7	2	9	
		3	6	10	2	10	6	7	2	10	
777	26-3200-3200-1	1	10	10	4	4	10	10	0	2	
		2	10	10	0	3	10	10	0	2	
		3	10	10	0	4	10	10	0	3	
779	23-4960-2320-5	1	10	10	10	10	8	9	8	9	
		2	10	10	10	10	8	8	8	9	
		3	10	10	10	10	9	9	8	9	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
Control A		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
Control B		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls. Superscripts indicate as follows: n = necrosis and s = stunting.

[c] Note: A - Tip necrosis on leaves of millet plants.

Table A-15. Results of primary test number 15 indicating phytotoxicity observed on test plants planted 9/1/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
488	05-1880-3640-1	1	10	10	10	10	9	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
Control A		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
Control B		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls.

Table A-16. Results of secondary test number 1 indicating phytotoxicity observed on test plants planted 4/13/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[c]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
1	36-1880-4080-2	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10[y]	10	
2	36-1880-4080-1	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	9	9	8	10	
		3	10	10	10	10	10	9	8	10	
3	36-2320-4520-2	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
5	36-1440-4080-1	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	2[n]	10	9	10	
7	36-1440-3640-2	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
9	36-1440-3640-1	1	--	--	--	--	--	--	--	--	
		2	10	10	8	10	9	6[s]	5[s]	9	
		3	10	10	8	10	9	6[s]	6[s,n]	8[n]	A
11	36-1440-4080-2	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10[y]	10	10	
13	36-1440-5400-1	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[c]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
14	36-1440-5400-2	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10[y]	10[y]	10	
		3	10	10	10	10	9	10[y]	10[y]	10	
15	36-2760-5400-1	1	--	--	--	--	--	--	--	--	
		2	10	10	8	9	10	10	9	9	
		3	10	10	6	9	5[n]	10	9	9	B
16	36-2760-5400-2	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	9	9[y]	10[y]	10	
17	36-3200-5400-1	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	2[n]	10	10	10	B
18	36-3200-5400-2	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10[y]	10[y]	10	
		3	10	10	10	10	10	10[y]	10[y]	10	
19	36-2760-5840-1	1	--	--	--	--	--	--	--	--	
		2	10	10	5	10	10	10	10	10	
		3	10	10	5	10	10	10	10	10	
20	36-2760-5480-2	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10[y]	10[y]	10	
21	36-2320-5840-1	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
22	36-1440-4960-2	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10[y]	10[y]	10	
		3	10	10	10	10	10	10[y]	10[y]	10	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[c]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
23	36-3200-4960-1	1	--	--	--	--	--	--	--	--	
		2	10	10	5	10	10	10	10	10	
		3	10	10	5	10	10	10	10	10	
24	36-3200-4960-2	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	9	10	10	10	
		3	10	10	10	10	9	10y	10y	10	
25	36-1030-4080-1	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
27	36-1050-1440-1	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
28	36-1030-4520-1	1	--	--	--	--	--	--	--	--	
		2	10	10	8	10	10	10	10	10	
		3	10	10	8	10	10	10	10	10	
30	36-1440-3200-1	1	--	--	--	--	--	--	--	--	
		2	10	10	3	10	10	9	3s	10	
		3	10	10	3	10	10	9	3s	9	
31	36-2320-3200-1	1	--	--	--	--	--	--	--	--	
		2	3	1	0	9	8	2s	0	6s	
		3	2	1	0	9	1	2s	0	4s	
32	36-2760-2320-1	1	--	--	--	--	--	--	--	--	
		2	9	8	0	10	9	6	0	9	
		3	9	8	0	10	9	7	0	8	
33	36-2320-2320-2	1	--	--	--	--	--	--	--	--	
		2	1	4	0	7	2s	3s	0	5	
		3	1	4	0	7	2s	3s	0	6	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[c]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
35	36-2760-2320-2	1	--	--	--	--	--	--	--	--	
		2	8	8	9	9	9	8	9	10	
		3	8	9	10	10	8	7	9	9	B
37	36-2320-3640-1	1	--	--	--	--	--	--	--	--	
		2	10	10	8	10	9	8	7^{s}	8	
		3	10	10	6	10	9	8	$7^{s,n}$	9	
39	36-1880-2320-1	1	--	--	--	--	--	--	--	--	
		2	3	2	2	9	9	2	4^{s}	6	
		3	3	2	2	9	9	2^{s}	$3^{s,y}$	9	
41	36-1880-2320-2	1	--	--	--	--	--	--	--	--	
		2	6	1	1	8	7	1	2	6	
		3	5	1	2	8	5	1^{s}	2^{s}	7	B
Control A		1	--	--	--	--	--	--	--	--	
		2	9	6	2	10	10	10	10	10	
		3	9	6	3	10	10	10	10	10	
Control B		1	--	--	--	--	--	--	--	--	
		2	2	2	0	6	8	2	0	6	
		3	1	2	0	7	7	2	0	7	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls. Superscripts indicate as follows: n = necrosis, s = stunting and y = yellowing.

[c] Notes: A - some tip necrosis on leaves of ryegrass plants; B - possible "damping off" on sugar beet.

Table A-17. Results of secondary test number 2 indicating phytotoxicity observed on test plants planted 4/21/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes[c]
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
46	36-2320-1440-2	1	--	--	--	--	--	--	--	--	
		2	2	3	1	1	1^s	2^s	1^s	1^s	
		3	3	4	0	1	2^s	3^s	0	2^s	A
59	36-2320-1440-1	1	--	--	--	--	--	--	--	--	
		2	8	9	0	0	2^s	3^s	0	0	
		3	9	10	0	0	2^s	3^s	0	0	B
Control A		1	--	--	--	--	--	--	--	--	
		2	10	5	3	8	10	10	10	10	
		3	10	10	8	10	10	10	10	10	
Control B		1	--	--	--	--	--	--	--	--	
		2	10	10	3	5	10	10	10	10	
		3	10	10	6	10	10	10	10	10	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls. Superscript indicates as follows: s = stunting.

Table A-18. Results of secondary test number 3 indicating phytotoxicity observed on test plants planted 6/8/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
63	36-1880-3640-2	1	9	9	7	8	6	8	4	5	
		2	10	10	8	8	6	7	3[s]	5[s]	
		3	10	10	8	8	6	7[y]	3[y,s]	5[y,n]	
239	24-2320-3200-3	1	8	8	9	8	5	4	5	6	
		2	10	10	10	10	5	4	5	6	
		3	10	10	10	10	5	4[y]	5[y]	6[y]	
260	36-2320-1880-2	1	0	1	2	2	1[s]	4[s]	1[s]	2[s]	
		2	2	4	2	4	1[s]	4[s]	1[s]	2[s]	
		3	2	5	2	4	2[s]	4[s]	1[s]	2[s]	
331	36-2320-1880-1	1	0	0	0	0	0	0	0	0	
		2	0	0	0	0	0	0	0	0	
		3	0	0	0	0	0	0	0	0	
Control A		1	10	2	8	8	10	10	10	10	
		2	10	2	8	8	10	10	10	10	
		3	10	2	8	8	10	10	10	10	
Control B		1	8	9	2	10	10	10	10	10	
		2	9	9	2	10	10	10	10	10	
		3	9	9	2	10	10	10	10	10	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls. Superscripts indicate as follows: n = necrosis, s = stunting and y = yellowing.

Table A-19. Results of secondary test number 4 indicating phytotoxicity observed on test plants planted 6/18/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
400	09-4201-1299-1	1	2	1	3	7	2s	2s	3s	3s	
		2	3	2	3	8	2s	2s,e	3s	3s	
		3	3	2	3	8	2s	2s	3s	4s	
Control A no sand		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
Control B sand		1	10	10	10	10	10	10	10	10	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
Control C sand		1	5	10	9	9	10	10	10	10	
		2	5	10	9	9	10	10	10	10	
		3	5	10	9	9	10	10	10	10	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls. Superscripts indicate as follows: e = epinasty and s = stunting.

Table A-20. Results of secondary test number 5 indicating phytotoxicity observed on test plants planted 9/20/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
460	36-1880-1880-1	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
514	36-1440-1030-1	1	--	--	--	--	--	--	--	--	
		2	10	10	4	10	10	10	5	10	
		3	10	10	4	10	10	10	6	10	
606	26-3200-5840-3	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10[y]	10	10	
628	36-1880-2760-1	1	--	--	--	--	--	--	--	--	
		2	6	2	2	4	5[s]	2[s]	3[s]	4[s]	
		3	6	2	2	4	4[s]	2[s]	3[s,n]	4[s]	
680	26-4080-3200-2	1	--	--	--	--	--	--	--	--	
		2	9	10	9	10	7	5[s]	8	8	
		3	9	10	9	10	8	5[s]	8	8	
682	26-3200-3200-3	1	--	--	--	--	--	--	--	--	
		2	2	6	0	9	2[s]	4[s]	0	8	
		3	2	6	0	9	2[s]	4[s]	0	8	
690	24-1440-3200-4	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
696	24-4520-5400-7	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	8	8	10	10	
		3	10	10	10	10	9	9	10	10	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
698	26-4960-5400-8	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
708	36-3200-1030-4	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10[y]	10	10	
712	36-3200-1440-4	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	9	9	
		3	10	10	10	10	10	10[y]	9	10	
726	24-2320-4080-5	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	6	8	10	10	
		3	10	10	10	10	6	8	10	10	
732	26-3640-3200-8	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	6	10	8	10	
		3	10	10	10	10	9	10	9	10	
738	26-3640-3200-3	1	--	--	--	--	--	--	--	--	
		2	10	10	6	10	6	8	10	10	
		3	10	10	10	10	7	8[y]	8	10	
740	26-3640-3200-1	1	--	--	--	--	--	--	--	--	
		2	0	0	0	0	0	0	0	0	
		3	0	0	0	0	0	0	0	0	
758	26-3640-5840-4	1	--	--	--	--	--	--	--	--	
		2	10	10	7	10	8	8	8	9	
		3	10	10	7	10	6	8[y]	8	9	

(continued)

Sample No.	Site designation	Week No.	Emergence rating[a]				Growth rating[b]				Notes
			Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
761	26-2760-3200-9	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
764	26-2760-3200-7	1	--	--	--	--	--	--	--	--	
		2	10	10	9	10	6	8	9	10	
		3	10	10	9	10	5	7	8	9	
768	26-4080-3200-1	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	9	6[s]	6[s]	10	
		3	10	10	10	10	8	6[s]	5[s]	10	
774	23-5840-2320-5	1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
778	26-3200-3200-1	1	--	--	--	--	--	--	--	--	
		2	4	2	3	9	4[s]	3[s]	3[s]	6	
		3	5	2	5	9	4[s]	3[s]	8	8	
Control A		1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	
Control B		1	--	--	--	--	--	--	--	--	
		2	10	10	10	10	10	10	10	10	
		3	10	10	10	10	10	10	10	10	

[a] Emergence rating key: Emergence of seedlings rated on a scale of 0-10 where 0 = no emergence and 10 = emergence comparable to controls.

[b] Growth rating key: Growth rated on a scale of 0-10 where 0 = no growth and 10 = growth of seedlings that is comparable to controls. Superscripts indicate as follows: n = necrosis, s = stunting and y = yellowing.

APPENDIX B(25)

GROWTH MEASUREMENTS

Data in Appendix B are the growth measurements of tops and roots of indicator plants grown in test soils. Growth measurements were taken from the same plants utilized in developing visual indications of plant injury reported in Appendix A. Observations of root abnormalities were recorded as notes.

Median top growth represents a measured value (cm) of the tops of typical plants within the row of a specific indicator plant. Maximum root growth represents a measured value (cm) of the roots of indicator plants following removal from soil and washing. All measurements were taken three weeks after planting.

Useful symptoms for identifying phytotoxicity include root stunting, supression of root hair production, clubbing of roots, and root reduction. Differences of 20% in growth are probably not significant. Differences of 100% in growth are probably very significant.

Differences in response among indicator plants to the same test soils may reflect differences in plant susceptibility to a particular phytotoxin. Certain plants may not be sensitive to specific contaminants or may require higher concentrations of contaminants for phytotoxicity symptoms to develop.

Although no explanation is available to fully account for those instances where root growth is enhanced, it may be due to differential watering or nutrient availability. Enhanced root growth is not recognized as a phytotoxic effect from soil contaminants.

APPENDIX B

GROWTH MEASUREMENTS

Table B-1. Results of primary test number 1 indicating growth measurements recorded on test plants planted 2/10/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Median top growth[a]				Maximum root growth[b]				Notes
		Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
1	36-1880-4080-2	2.5	2.5	5.0	8.0	3.5	3.0	5.0	8.0	
2	36-1880-4080-1	0	0	0	4.5	0	0	0	5.0	
3	36-2320-4520-2	2.5	1.5	2.0	4.5	4.0	3.0	3.0	4.5	
5	36-1440-4080-1	4.5	4.5	6.5	8.0	5.0	4.5	6.5	8.0	
7	36-1440-3640-2	4.0	4.0	5.0	7.0	4.5	4.5	6.0	7.0	
9	36-1440-3680-1	1.5	0	0	1.0	1.5	0	0	1.0	
11	36-1440-4080-2	3.5	2.5	4.0	5.0	3.5	3.0	4.0	5.0	
13	36-1440-5400-1	2.5	3.5	6.5	8.0	2.5	3.5	6.5	8.0	
14	36-1440-5400-2	3.5	3.5	4.5	6.5	4.0	3.5	5.5	7.0	
15	36-2760-5400-1	2.0	3.0	4.5	6.5	Died	3.5	5.5	7.0	
16	36-2760-5400-2	4.5	4.5	5.5	7.5	4.5	4.5	5.5	7.5	
17	36-3200-5400-1	5.5	5.0	7.0	7.5	5.5	5.0	8.0	9.0	
18	36-3200-5400-2	2.0	2.5	4.0	6.0	2.5	3.0	5.0	6.5	
19	36-2760-5840-1	3.5	3.0	5.0	6.0	3.5	3.0	5.5	6.0	
20	36-2760-5480-2	2.5	2.5	4.0	7.0	2.5	2.5	5.5	7.0	
21	36-2320-5840-1	4.0	4.0	5.0	9.0	4.0	4.0	6.0	9.0	
22	36-1440-4960-2	3.5	3.5	5.0	6.0	3.5	3.5	5.0	6.0	
23	36-3200-4960-1	4.5	4.5	6.5	8.0	4.5	4.5	7.0	9.0	
24	36-3200-4960-2	2.5	2.5	4.0	6.0	2.5	2.5	5.0	7.0	
Control		5.5	5.0	6.0	9.0	5.5	6.0	8.0	9.0	

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth: maximum root length of test plants measured 3 weeks after planting.

Table B-2. Results of primary test number 2 indicating growth measurements recorded on test plants planted 2/18/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No	Site designation	Median top growth[a]				Maximum root growth[b]				Notes
		Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
25	36-1030-4080-1	3.5	2.5	5.0	7.0	4.0	5.5	4.6	5.2	
27	36-1050-1440-1	4.5	4.0	5.0	7.5	4.9	7.4	6.2	3.3	
28	36-1030-4520-1	4.5	4.5	6.0	8.0	3.6	3.7	6.5	7.7	
30	36-1440-3200-1	3.5	4.0	8.5	7.0	3.6	4.4	6.3	7.6	
31	36-2320-3200-1	2.0	1.5	Dead	3.0	1.2	0.5	Dead	0.5	
32	36-2760-2320-1	4.0	3.5	5.0	6.0	4.2	4.4	4.3	6.6	
33	36-2320-2320-2	3.0	2.5	3.5	7.55	3.3	4.9	5.6	6.3	
35	36-2760-2320-2	3.0	2.0	3.5	4.5	3.6	5.3	4.9	5.1	
37	36-2320-3640-1	1.0	1.0	1.0	7.5	--	--	--	--	
39	36-1880-2320-1	3.5	3.5	4.0	8.0	3.4	4.5	5.7	6.9	
41	36-1880-2320-2	4.0	3.5	5.0	8.0	4.2	6.0	5.0	9.0	
Control		6.5	5.5	8.5	10	6.6	9.1	8.0	9.8	

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth: maximum root length of test plants measured 3 weeks after planting.

Table B-3. Results of primary test number 3 indicating growth measurements recorded on test plants planted 3/24/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No	Site designation	Median top growth[a]				Maximum root growth[b]				Notes[c]
		Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
43	35-5400-3640-3	4.4	3.9	3.8	6.5	5.8	7.4	6.6	8.2	
45	35-5400-3640-3	3.3	3.2	3.2	6.5	7.3	7.1	8.1	7.1	
46	36-2320-1440-2	0.5	0.8	0.4	1.0	0.3	0.7	0.2	0.2	A
49	35-4960-4520-5	2.4	3.3	3.0	6.1	2.9	5.0	4.1	0.9	B
50	35-4960-4520-2	3.2	3.8	3.0	2.8	4.8	4.4	0.7	0.9	
51	35-4960-4520-3	3.5	4.0	3.0	4.0	4.3	5.4	2.6	11.2	
55	35-4960-4520-1	3.4	3.8	5.4	8.9	6.9	4.9	6.8	9.9	
56	35-2760-4080-3	2.2	3.3	1.0	1.5	3.2	4.3	0.4	0.4	B
59	36-2320-1440-1	0.3	0	0	0	0	0	0	0	
61	35-4960-4520-4	2.8	3.0	0.3	0.7	3.6	4.5	0.7	0.7	B, C
62	36-1030-4520-2	2.6	2.8	4.0	6.6	3.4	4.2	6.8	7.2	
63	36-1880-3640-2	3.5	1.2	0.8	4.2	4.7	2.4	1.9	1.6	
67	36-1880-3640-1	1.9	1.7	1.0	2.6	2.4	1.5	0.7	1.9	
68	36-2320-3640-2	3.9	2.7	0	6.2	2.9	3.8	0	3.8	
69	36-1030-5840-2	3.0	3.4	4.9	6.6	4.2	4.6	3.9	4.9	
73	35-2760-4080-1	3.6	3.9	5.1	7.1	4.3	5.2	5.1	4.3	
74	36-2760-1880-2	3.8	4.6	2.6	3.1	7.2	5.6	1.1	0.8	B, C
75	36-1030-1880-2	4.2	3.6	4.3	7.6	7.3	4.9	7.2	7.2	
76	36-1030-5840-1	4.1	3.8	4.1	7.4	5.1	4.7	4.9	5.3	
79	36-1440-3200-2	4.0	4.2	4.2	8.5	4.6	5.3	7.9	9.2	
80	35-2760-4080-4	2.5	2.7	2.7	8.0	3.9	4.2	5.3	6.3	
81	26-1880-1880-1	4.5	4.7	4.1	8.0	3.1	5.2	2.9	5.3	
Control A		5.5	5.0	5.5	9.5	5.4	9.5	8.3	5.3	
Control B		5.5	5.0	6.0	9.0	4.4	6.4	6.3	4.8	

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth: maximum root length of test plants measured 3 weeks after planting.

(continued)

[c] Notes: A - root growth greatly suppressed on sugar beet and ryegrass; B - suppression of root growth and root hair productivity,. particularly on grass species; C - "clubbing" of roots on ryegrass and millet.

Table B-4. Results of primary test number 4 indicating growth measurements recorded on test plants planted 3/31/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Median top growth[a]				Maximum root growth[b]				Notes
		Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
86	23-5840-4960-3	3.0	2.8	4.5	6.2	6.3	5.7	5.1	7.2	
87	23-4080-3200-4	3.0	3.2	4.0	5.5	6.2	6.1	6.3	6.5	
89	23-5840-4960-1	3.4	3.8	3.4	6.0	4.9	5.0	4.0	4.6	
92	26-5400-1880-3	2.8	3.6	4.1	6.6	4.5	5.3	6.2	8.1	
93	35-2760-4080-5	3.3	3.5	4.4	6.7	5.2	5.8	5.4	8.2	
96	26-4960-4960-1	5.4	6.0	4.9	9.1	7.1	5.9	4.9	6.9	
97	23-4080-4960-1	5.6	6.1	4.8	9.3	4.2	5.1	6.2	6.1	
99	23-2320-4080-2	3.5	4.2	4.8	8.6	5.5	6.7	5.5	7.5	
100	23-4080-3200-1	5.3	5.9	4.1	10.0	6.0	5.1	5.1	8.2	
101	23-5840-4960-4	3.1	3.2	3.5	7.7	5.1	6.5	4.5	7.2	
102	23-2320-4080-4	3.5	3.6	4.1	7.6	10.1	7.2	5.6	6.3	
104	23-4060-4960-4	3.4	3.5	3.9	7.4	4.2	4.9	4.2	7.2	
105	23-4080-3200-2	3.0	4.2	4.6	7.3	5.7	6.0	7.2	7.2	
107	23-4080-4960-2	3.4	4.2	4.9	7.8	5.8	9.2	5.0	9.5	
110	26-1880-1880-2	3.6	3.8	4.5	6.3	5.5	5.1	4.7	7.3	
111	36-2320-1030-2	2.6	4.0	2.1	5.8	2.4	5.5	2.1	0.6	
113	36-2760-1880-1	2.3	3.5	0.5	4.2	1.9	1.8	0	1.2	A
114	26-5400-1880-1	5.1	5.1	5.0	10.0	5.7	6.2	7.1	10.2	
115	26-4960-4960-5	5.2	5.4	5.1	9.3	4.7	4.9	5.3	5.1	
117	36-5400-1880-2	4.4	3.6	4.4	8.1	6.2	7.2	6.3	6.9	
119	26-5400-1880-4	2.5	3.1	4.1	6.9	7.1	6.2	5.7	7.1	
121	25-4960-2320-1	4.6	5.0	4.9	10.0	7.1	5.2	5.8	6.2	
123	35-5400-3640-2	4.2	4.3	4.9	8.9	7.7	5.0	6.6	6.7	
126	35-2760-5400-3	4.1	4.2	4.6	8.8	4.5	3.9	6.4	6.1	
127	09-1371-4731-4	3.2	4.0	5.0	8.6	5.2	5.2	6.9	7.4	
Control A		5.5	5.7	5.1	10.5	4.6	3.8	6.3	6.7	
Control B		5.2	5.2	5.0	10.3	5.9	5.9	5.9	6.4	

(continued)

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth: maximum root length of test plants measured 3 weeks after planting.

[c] Notes: A - root hair suppression on sugar beet and root growth inhibition and "clubbing" of roots of ryegrass.

Table B-5. Results of primary test number 5 indicating growth measurements recorded on test plants planted 4/1/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Median top growth[a]				Maximum root growth[b]				Notes
		Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
129	23-5840-4960-2	4.1	3.6	2.5	8.0	5.6	5.7	4.9	6.5	
131	09-1371-4731-3	3.5	4.1	4.3	6.8	3.7	5.1	5.8	6.8	
133	09-1164-3572-4	4.7	4.2	4.6	8.3	3.7	5.5	6.4	7.7	
135	09-1164-3572-5	4.0	4.2	4.3	7.5	5.6	5.7	5.6	7.5	
137	09-1164-3572-3	4.7	3.8	4.2	9.6	5.2	3.1	4.6	4.9	A
140	26-2320-3640-4	4.9	4.1	4.2	7.7	5.6	4.6	7.7	7.9	
141	35-4960-2320-2	3.8	3.9	4.5	8.0	4.7	5.2	6.4	6.3	
143	26-1880-1880-5	4.1	3.7	3.5	6.6	4.6	5.5	5.1	6.7	
145	23-2320-4080-3	4.1	3.7	4.9	8.0	5.9	7.4	7.5	6.1	
147	23-4080-4960-3	5.1	4.9	4.6	7.2	4.3	5.2	5.6	8.6	B
149	09-1164-3572-1	5.6	5.7	6.1	9.7	6.1	6.0	6.3	10.2	
151	23-3200-1440-2	4.2	4.8	4.7	6.6	4.4	5.0	5.2	5.0	
153	35-4960-2320-3	4.2	4.1	4.3	6.6	7.9	5.7	5.5	7.7	
155	35-2760-5400-1	5.0	5.5	5.7	10.1	4.9	5.7	6.4	8.5	
157	26-1880-1880-4	3.8	3.3	3.4	8.3	3.9	4.8	4.9	5.3	
160	26-4960-4960-2	4.9	4.6	3.8	7.5	4.6	5.5	5.0	7.1	
161	35-2760-4080-2	5.3	4.2	4.6	8.4	5.3	4.6	7.0	6.7	
162	26-1880-1880-3	3.7	3.8	4.2	6.1	6.2	5.1	5.2	6.1	
163	35-2760-5400-2	4.2	3.9	4.2	7.7	5.2	5.1	6.2	6.1	
165	35-2760-5400-5	4.8	4.4	4.9	6.6	5.2	3.8	5.1	6.3	
167	26-1880-5840-5	3.5	3.7	3.7	8.2	5.1	6.4	6.0	7.1	B
168	35-2760-5400-4	4.6	4.5	4.1	8.2	4.1	4.1	6.0	5.5	
169	26-4960-4960-4	4.8	3.9	4.2	8.0	3.7	4.2	4.0	7.9	
171	26-4960-4960-3	4.0	3.8	4.1	8.1	4.5	4.6	4.9	6.7	
173	26-1880-5840-3	4.2	3.9	4.1	8.1	5.8	5.2	4.8	5.9	
Control A		6.6	5.3	5.5	12.2	5.2	4.8	5.8	5.1	
Control B		6.1	5.8	5.3	11.5	4.9	5.2	5.6	5.3	

(continued)

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth: maximum root length of test plants measured 3 weeks after planting.

[c] Notes: A - some root hairs and root growth suppression on mustard; B - root hair suppression on sugar beet.

Table B-6. Results of primary test number 6 indicating growth measurements recorded on test plants planted 5/5/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No	Site designation	Median top growth[a]				Maximum root growth[b]				Notes
		Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
175	08-2403-5662-1	5.7	5.7	5.0	11.1	5.1	6.1	5.5	9.2	
177	22-3200-2320-5	4.2	4.3	5.2	6.0	3.5	5.1	6.0	8.9	
179	23-3200-2320-2	4.8	5.9	5.7	10.5	3.2	5.1	6.5	5.3	
181	22-3200-2320-1	5.6	6.5	6.2	10.9	5.9	4.1	5.6	5.2	
183	08-5579-5690-2	5.6	6.4	6.4	10.6	6.1	6.4	10.8	10.9	
185	08-5101-5178-2	5.6	4.8	5.2	11.1	4.8	4.6	7.8	9.5	
187	24-3200-1440-2	5.2	5.0	5.5	10.1	4.8	3.7	5.1	5.9	
189	24-2320-3200-5	4.4	4.8	5.6	10.3	6.4	4.3	5.4	12.9	
191	24-3200-1440-5	4.2	4.3	5.1	10.6	8.2	9.6	6.8	12.7	
193	08-2432-1471-1	6.6	7.6	6.5	12.2	4.2	3.6	5.9	6.5	
195	22-4960-1440-4	4.3	4.5	9.3	9.2	5.2	6.8	10.1	11.1	
197	24-3200-4960-2	5.8	6.9	6.1	10.8	9.5	5.7	5.6	9.5	
199	24-4960-5840-2	4.6	5.2	6.1	10.6	6.8	6.5	7.1	8.9	
201	24-4960-5840-5	4.8	4.6	4.8	9.2	4.6	5.9	6.9	6.3	
203	24-2320-3200-2	7.1	7.2	6.1	11.5	7.7	4.6	4.7	12.5	
205	08-2403-5662-3	4.2	4.4	4.8	9.1	7.2	5.5	6.1	13.2	
207	08-5101-5178-1	7.2	6.9	5.8	12.3	7.5	4.6	8.0	8.1	
209	08-2432-1471-4	4.9	6.1	7.1	11.2	4.0	4.9	6.9	11.1	
211	08-5579-5690-3	5.1	5.2	5.3	10.8	3.9	4.3	7.2	12.6	
213	08-2403-5662-4	4.2	4.6	5.2	10.6	4.6	5.2	5.3	13.6	
215	08-3142-1995-2	5.7	4.8	4.3	6.1	3.3	4.7	6.1	7.3	
217	08-3142-1995-1	6.6	7.2	6.1	12.7	4.2	4.7	7.2	12.8	
219	36-4960-4080-2	5.9	5.6	5.6	11.2	4.6	5.2	6.2	10.5	
221	36-4960-4080-4	4.6	5.2	5.1	9.8	5.1	6.6	7.5	12.2	
223	24-4960-5840-4	4.8	4.8	4.6	9.9	3.8	3.9	5.7	5.5	
225	24-4080-3200-1	7.2	7.8	6.6	12.5	4.9	3.2	6.2	6.2	
227	24-4080-3200-2	4.9	5.8	5.1	9.7	4.6	7.9	7.0	9.2	
229	24-3200-1440-3	4.8	5.0	5.1	9.1	5.1	4.9	5.3	7.2	

(continued)

Sample No.	Site designation	Median top growth[a]				Maximum root growth[b]				Notes
		Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
231	24-4960-5840-3	3.7	4.6	5.1	9.0	3.3	6.1	4.9	5.9	
233	22-4960-3200-4	4.5	5.0	4.6	10.0	9.1	6.9	4.2	12.5	
235	09-4201-1299-3	4.6	5.9	5.9	10.8	3.1	4.0	5.6	7.2	
237	09-4201-1299-4	4.3	4.2	5.7	10.3	3.6	4.9	6.2	9.3	
239	24-2320-3200-3	2.9	0	0	6.8	3.8	0	0	3.1	
Control A		6.2	7.4	8.1	14.8	4.5	4.2	6.5	5.6	
Control B		7.1	7.1	8.3	13.4	5.0	4.3	5.2	10.1	

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth: maximum root length of test plants measured 3 weeks after planting.

Table B-7. Results of primary test number 7 indicating growth measurements recorded on test plants planted 5/13/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No	Site designation	Median top growth[a]				Maximum root growth[b]				Notes[c]
		Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
241	36-5840-2760-2	5.5	5.0	4.3	9.8	4.4	4.9	6.3	8.3	
243	36-5840-2760-1	7.8	6.7	6.5	11.3	5.1	4.9	6.2	5.7	
245	08-5579-5690-4	5.1	5.9	6.2	10.4	3.4	3.4	5.2	10.9	
247	08-3142-1995-4	4.5	5.1	5.8	11.1	3.6	6.0	6.6	8.3	
249	36-5400-4960-1	5.9	6.1	6.6	12.8	4.5	5.8	5.3	8.2	
251	36-4080-4960-1	6.6	6.5	10.1	10.5	8.9	4.7	9.4	10.5	
252	24-3200-1440-1	6.2	6.4	5.8	13.1	5.3	6.2	4.2	7.0	
254	24-3200-4960-1	7.5	6.8	7.4	13.2	3.9	4.9	5.9	5.8	
256	36-2320-4960-4	5.0	4.1	4.4	8.1	4.1	3.2	5.2	5.2	
258	36-2320-1880-4	4.0	5.1	1.5	3.5	4.7	4.3	0.3	4.7	A
260	36-2320-1880-2	0	0	0	0	0	0	0	0	
262	36-4520-2760-1	6.0	6.4	5.6	10.1	3.7	3.0	3.5	10.2	
264	36-5840-2760-3	5.0	4.5	4.1	9.2	4.0	5.0	6.1	6.2	
266	36-5400-4960-5	4.2	4.4	4.8	9.4	4.2	5.2	4.5	7.0	
268	36-5400-4960-3	4.2	4.8	4.0	9.8	3.5	3.6	4.5	5.5	
270	26-1880-5840-1	6.3	6.4	5.4	13.5	3.5	5.2	5.5	8.1	
271	26-2320-3640-3	3.8	4.5	4.0	11.1	3.1	3.3	4.5	10.1	
272	35-5400-3640-1	6.8	8.5	8.0	17.1	4.1	5.6	6.2	4.1	
273	36-2320-1030-1	5.1	7.2	3.8	3.1	3.0	4.5	1.0	1.0	B
274	36-4520-2760-3	4.0	5.1	5.1	6.5	2.5	6.9	4.7	8.0	
276	36-2320-4960-1	2.4	3.0	4.1	6.0	2.5	1.8	1.9	8.0	
277	36-1880-1440-2	2.0	3.8	0.3	0.2	0.9	3.3	0.2	0.1	
278	36-1880-1440-1	2.5	3.2	0.3	0.7	1.7	1.9	0.2	0.2	C
280	36-4080-4960-2	3.0	4.6	5.0	8.0	5.2	4.0	4.9	6.0	
282	36-4080-4960-4	4.2	4.5	5.5	8.2	3.8	3.8	8.1	8.1	
283	36-5840-2760-4	4.3	4.0	5.1	8.3	5.9	5.6	4.7	5.1	
285	24-1440-5840-1	6.1	6.5	6.9	9.2	5.0	5.1	5.5	7.3	
287	24-2320-5840-1	5.1	5.0	6.1	9.1	5.9	5.6	4.7	5.1	
289	24-3200-5840-1	6.9	7.1	6.1	9.2	3.2	5.4	3.2	5.1	
291	24-2320-5840-2	3.8	4.8	2.1	3.5	4.3	3.4	0.4	0.6	A, D
Control A		8.5	9.1	8.8	3.8	3.5	3.4	3.6	5.9	
Control B		8.7	8.8	8.6	12.9	3.5	5.0	6.9	7.0	

(continued)

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth: maximum root length of test plants measured 3 weeks after planting.

[c] Notes: A - root stunting on millet and ryegrass; B - root stunting and root hair suppression of grasses; C - hypocotyl swelling at base and root hair suppression on all test species; D - "clubbing" of roots on grass species.

Table B-8. Results of primary test number 8 indicating growth measurements recorded on test plants planted 5/19/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No	Site designation	Median top growth[a]				Maximum root growth[b]				Notes[c]
		Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
293	24-4080-5840-2	6.2	6.2	8.1	11.	4.0	4.0	5.6	10.3	
295	24-4080-5840-1	8.0	8.0	8.3	11.3	4.0	5.0	6.0	6.5	
297	36-4520-2760-4	5.0	5.5	5.5	9.0	5.0	6.1	6.2	5.7	
299	36-1880-3200-1	5.8	2.0	4.0	1.2	2.8	0.7	2.0	1.0	A
301	36-2760-1440-4	5.0	4.2	4.0	11.4	2.6	3.4	5.0	5.6	
303	36-2760-1440-2	5.7	5.5	3.1	5.7	3.0	4.3	0.9	1.1	B
305	08-2403-5662-5	5.0	5.5	6.3	9.5	2.6	3.8	4.7	7.0	
307	36-4080-4960-3	5.2	5.3	5.0	12.2	4.0	2.7	4.2	7.2	
309	36-2320-4960-3	5.5	3.6	5.0	12.0	3.3	2.5	3.6	4.2	
311	36-2320-1880-3	3.8	4.5	0.5	4.0	1.3	2.4	0.3	0.7	B
313	24-3200-5840-2	5.1	5.4	4.0	9.8	3.6	5.2	4.2	6.4	
315	36-2760-1440-3	5.2	5.8	4.0	8.6	4.1	5.4	2.3	4.2	
317	36-2760-1440-1	5.6	7.6	0	5.0	3.1	4.6	0	0.5	B
319	36-4520-2760-2	5.1	5.6	4.6	9.0	3.6	5.2	2.7	6.4	
321	36-5400-4960-4	5.0	5.0	6.0	12.1	5.2	4.2	5.4	7.1	
323	36-4960-4080-1	7.0	6.6	6.2	12.4	6.5	3.2	4.7	7.9	
325	08-3142-1995-5	5.3	5.0	6.0	12.0	5.6	5.7	7.4	8.1	
327	36-1880-3200-2	6.5	5.0	5.5	12.2	4.4	3.4	4.5	7.2	
329	36-2320-4960-2	5.6	6.5	6.5	12.1	3.2	4.2	4.2	9.2	
331	36-2320-1880-1	0	0	0	0	0	0	0	0	
334	22-4960-3200-5	6.1	5.1	1.5	4.5	7.3	8.0	0.5	0.9	B
336	36-5400-4960-2	5.9	6.0	5.6	10.7	3.9	4.1	4.3	4.8	
338	08-5101-5178-3	6.3	6.0	6.0	9.5	6.0	6.0	4.7	6.8	
340	08-5579-5690-1	8.0	7.7	6.0	13.7	6.0	3.6	3.8	12.1	
342	08-2432-1471-3	5.1	5.6	5.0	10.0	4.3	8.1	6.1	9.9	
344	08-3142-1995-3	6.5	7.0	6.0	11.0	4.5	4.5	4.0	7.5	
346	36-4960-4080-3	6.2	5.2	6.0	11.7	4.2	4.5	7.9	10.0	

(continued)

Sample No.	Site designation	Median top growth[a]				Maximum root growth[b]				Notes[c]
		Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
348	08-2403-5662-2	6.0	6.1	6.4	11.7	4.1	7.0	6.0	9.2	
350	22-2300-2320-4	5.0	5.6	6.0	7.0	5.2	6.4	6.0	5.6	
352	22-3200-2320-3	5.6	6.3	6.0	10.2	3.6	3.7	5.2	7.1	
Control A		9.0	11.0	13.0	14.6	5.0	5.7	13.7	7.0	
Control B		8.9	7.1	10.1	11.5	4.3	5.6	7.0	10.3	

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth: maximum root length of test plants measured 3 weeks after planting.

[c] Notes: A - root growth suppression on mustard, millet and ryegrass; B - severe root reduction on grasses.

Table B-9. Results of primary test number 9 indicating growth measurements recorded on test plants planted 5/26/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Median top growth[a]				Maximum root growth[b]				Notes
		Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
354	09-2467-5762-5	4.5	5.9	5.5	10.4	5.5	4.9	4.7	6.1	
356	09-4275-4774-1	6.2	5.9	9.1	12.2	4.3	5.4	4.7	9.4	
358	23-4080-4960-5	4.8	5.1	5.8	12.1	4.1	4.3	4.6	4.3	
360	22-4960-3200-2	5.0	5.6	6.1	11.8	6.0	5.7	5.9	7.0	
362	24-3200-1440-4	4.8	5.2	5.9	12.9	2.8	5.6	7.2	7.6	
364	22-4960-3200-3	5.3	5.2	5.5	12.5	5.1	6.4	8.4	5.2	
366	22-4960-1440-5	4.2	4.8	4.6	10.4	4.9	5.3	9.1	6.6	
368	08-2432-1471-2	5.5	5.2	6.1	11.6	4.6	6.7	8.6	8.6	
370	24-4080-3200-3	4.5	4.7	5.1	9.2	4.3	7.4	7.9	10.3	
372	09-2467-5762-3	4.3	5.6	6.7	11.4	5.0	4.5	6.1	7.2	
374	09-2467-5762-4	5.1	5.1	6.5	12.0	5.1	7.7	9.7	10.2	
376	09-1371-4731-5	4.1	5.1	6.4	11.8	4.9	8.1	7.9	10.2	
378	36-1030-1440-2	3.9	5.1	5.9	4.9	6.1	6.9	5.1	4.0	
380	26-1880-5840-2	5.3	6.8	6.5	11.1	6.3	5.1	8.8	8.9	
382	26-2320-3640-2	6.4	6.9	7.1	13.2	6.1	7.1	9.2	12.1	
384	23-4080-3200-3	6.5	6.8	6.9	12.8	4.7	9.3	11.1	10.2	
386	23-3200-1440-3	7.3	6.3	7.2	13.8	6.2	7.2	8.1	10.2	
388	23-3200-1440-4	4.8	5.4	4.9	11.9	5.1	5.6	7.1	8.1	
390	09-2467-5762-2	4.8	6.1	7.1	13.1	5.6	7.5	8.9	10.7	
392	09-2467-5762-1	6.3	7.2	12.8	14.5	7.7	8.6	9.5	9.7	
394	09-1371-4731-2	5.3	5.8	5.2	14.3	5.2	9.5	7.6	12.1	
396	09-4201-1299-2	6.2	5.9	8.2	12.1	4.9	5.6	9.2	8.1	
398	09-4275-4774-4	5.2	5.4	6.1	11.8	6.7	10.1	10.3	10.2	
400	09-4201-1299-1	7.1	0	10.0	11.2	5.9	0	5.6	10.7	
401	09-4275-4774-3	5.1	5.7	7.1	12.8	5.6	3.9	9.6	10.1	
403	09-4275-4774-2	5.9	5.9	11.1	13.1	6.7	6.0	7.4	10.3	
405	23-4080-3200-5	5.1	5.4	6.1	11.5	5.6	5.1	7.4	9.1	
406	23-2320-4080-1	7.2	8.1	8.8	14.5	6.6	5.7	7.3	7.7	

(continued)

Sample No.	Site designation	Median top growth[a]				Maximum root growth[b]				Notes
		Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
407	26-2320-3640-1	6.8	7.9	11.1	13.1	5.9	7.7	9.1	13.0	
408	26-2320-3640-1	5.2	4.9	5.1	12.2	4.1	8.1	5.3	9.1	
409	26-2320-3640-1	5.3	4.9	5.1	12.1	6.5	5.6	6.7	8.1	
411	26-1880-5840-1	4.1	4.1	4.2	10.1	3.8	4.9	7.2	8.1	
412	23-3200-1440-5	5.8	5.1	6.8	10.6	5.5	8.2	9.1	10.1	
413	22-4960-1440-3	5.1	5.2	6.1	12.9	6.5	10.4	7.1	7.3	
415	22-4960-1440-2	6.2	6.0	7.5	13.1	5.2	8.0	7.9	8.2	
417	24-2320-3200-1	4.9	5.2	6.9	12.5	10.1	7.8	11.1	7.6	
419	09-4275-4774-5	5.1	6.7	7.3	13.4	7.1	8.0	6.4	9.0	
421	22-4960-1440-1	7.4	7.5	9.1	13.3	6.5	7.4	7.6	9.2	
423	09-4201-1299-5	7.0	6.8	8.0	12.3	4.2	7.1	7.1	9.5	
425	24-2320-3200-1	9.1	9.3	10.2	14.2	5.9	6.1	4.3	10.3	
427	24-4960-5840-1	8.1	9.1	9.8	14.8	4.9	6.1	7.2	11.1	
429	22-4960-3200-1	6.9	6.8	7.8	12.8	4.4	4.2	4.1	12.2	
431	09-1371-4731-1	6.0	5.9	8.1	12.5	5.7	4.6	7.3	10.2	
433	09-1164-3572-2	8.4	8.2	13.7	15.1	5.1	5.6	9.7	11.2	
435	23-3200-1440-1	8.9	7.5	13.6	15.5	5.1	4.2	7.3	9.1	
Control A		11.9	10.1	14.4	15.7	4.5	5.2	8.9	9.8	
Control B		11.2	9.2	13.9	15.3	3.5	6.6	6.3	7.7	

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth: maximum root length of test plants measured 3 weeks after planting.

Table B-10. Results of primary test number 10 indicating growth measurements recorded on test plants planted 7/20/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No	Site designation	Median top growth[a]				Maximum root growth[b]				Notes[c]
		Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
437	23-2320-5840-5	3.8	4.8	4.5	8.0	2.4	7.7	8.4	11.3	
439	23-2320-5840-4	3.2	4.1	4.8	7.8	5.5	4.1	7.2	9.1	
441	23-2320-5840-2	3.3	4.2	4.2	7.1	3.1	5.9	7.7	8.1	
443	26-4080-5400-4	4.3	4.8	4.9	8.1	5.5	4.0	5.5	4.6	
445	26-4080-5400-3	4.6	5.6	5.6	12.1	5.0	4.5	7.4	7.3	
447	36-1880-1880-4	2.5	4.6	3.6	10.4	4.1	6.1	3.0	8.0	
449	36-1880-1030-4	4.1	5.1	4.9	9.3	6.4	7.4	5.7	12.9	
451	36-4080-5400-1	6.6	7.3	6.2	10.1	4.9	6.5	8.5	12.1	
453	36-1880-1030-2	6.2	6.3	5.7	12.8	7.2	6.4	7.8	9.2	
455	36-1880-1030-1	4.8	5.9	7.9	10.9	3.4	7.7	8.4	8.1	
457	36-1880-1880-3	7.3	7.5	8.4	12.0	3.2	10.9	9.4	8.8	
459	36-1880-1800-1	7.3	7.2	6.2	4.5	4.7	4.4	4.7	0.6	A
461	06-5840-4520-1	6.8	7.2	10.1	12.1	3.8	3.7	6.8	10.3	
463	06-5840-4520-2	4.3	4.3	5.2	9.8	5.0	5.1	6.4	8.6	
465	06-5400-3640-2	4.5	5.5	4.9	7.8	3.7	4.9	7.7	10.5	
467	26-4080-5400-8	4.2	5.1	6.0	11.5	3.4	5.5	9.3	13.0	
469	26-4080-5400-7	4.2	4.5	5.6	12.8	3.3	6.7	9.1	10.2	
471	26-4080-5400-6	5.1	4.7	5.9	11.2	5.1	7.2	8.5	11.2	
473	24-2320-4960-3	4.6	5.4	4.7	9.5	6.2	5.1	6.7	9.1	
475	24-2320-4960-2	5.2	5.5	5.6	9.8	4.5	7.2	7.9	9.3	
477	24-2320-4960-4	5.0	6.2	7.1	11.6	6.2	12.9	8.5	9.7	
479	24-1440-5840-2	3.5	4.5	4.6	6.6	2.4	5.0	7.0	7.7	
481	24-1440-5840-3	4.8	5.2	4.8	8.8	7.4	6.4	7.2	9.1	
483	36-1880-1880-2	5.0	5.5	8.1	13.5	6.0	10.1	9.0	11.6	
485	05-1440-3200-1	7.7	7.3	11.6	15.1	7.0	8.7	11.6	10.2	
489	05-1880-3640-2	5.0	5.5	6.1	10.9	4.3	5.1	10.1	6.2	
491	26-5840-4520-5	5.1	5.0	6.2	8.6	3.7	4.6	10.1	16.5	
493	36-4080-4960-5	6.2	6.0	7.2	13.8	11.6	8.2	10.1	11.3	

(continued)

Sample No.	Site designation	Median top growth[a]				Maximum root growth[b]				Notes[c]
		Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
494	26-5840-4520-4	5.0	6.1	7.2	12.8	4.8	12.1	8.2	9.9	
495	26-5840-4520-6	4.4	4.6	5.2	9.1	4.0	5.9	7.0	10.8	
497	23-4080-5840-2	4.1	6.1	6.5	10.5	4.6	6.2	8.1	10.4	
Control	A	8.3	8.1	11.5	15.0	9.2	6.2	9.1	9.7	
Control	B	6.3	6.2	11.3	14.1	6.0	4.7	6.2	9.3	

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth: maximum root length of test plants measured 3 weeks after planting.

[c] Notes: A - "clubbing" of roots and reduced root growth on grasses.

Table B-11. Results of primary test number 11 indicating growth measurements recorded on test plants planted 7/22/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Median top growth[a]				Maximum root growth[b]				Notes[c]
		Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
497	23-4080-5840-2	4.6	5.8	5.2	12.3	5.3	5.3	7.4	6.4	
499	23-3200-5840-4	4.7	4.5	5.1	8.9	6.0	5.5	7.1	8.4	
501	23-4960-5840-1	7.6	8.3	8.2	11.1	6.0	5.2	9.2	12.9	
503	23-4960-1440-6	4.2	4.4	4.9	11.2	6.4	7.0	8.0	12.5	
505	24-1440-1440-3	4.2	4.9	4.2	9.1	5.8	6.3	7.0	10.0	
506	23-4960-1440-4	4.6	6.5	5.6	10.1	4.5	5.0	7.5	9.2	
507	23-5840-1440-2	6.1	7.1	6.9	12.4	4.7	7.2	7.7	14.4	
509	26-3640-5840-6	4.8	5.5	6.3	10.9	5.7	4.9	7.4	9.3	
511	36-1440-1030-3	4.2	5.9	5.3	11.0	5.0	6.0	8.1	8.3	
513	36-1440-1030-1	6.2	10.1	3.6	4.9	3.5	6.1	2.0	1.7	A, B
515	23-5840-5840-4	5.6	5.6	5.5	11.1	5.0	7.3	8.1	7.2	
517	23-2320-5840-3	6.1	5.3	5.2	11.2	5.1	6.1	8.7	7.1	
519	23-3200-5840-1	5.9	6.1	5.3	11.8	6.4	6.1	7.9	10.7	
521	23-5840-1440-7	4.9	4.6	5.8	10.1	5.3	6.1	8.6	8.5	
522	23-4960-1440-1	7.1	7.9	4.6	12.1	5.8	8.9	6.1	10.1	
523	23-4080-1440-4	9.1	8.2	9.5	12.9	8.0	6.0	13.0	12.8	
524	23-4080-1440-4	5.3	5.1	5.3	11.1	5.5	6.9	5.3	6.0	
526	26-3640-5840-2	8.1	8.0	9.1	12.6	5.0	4.5	7.4	9.8	
527	26-3200-5840-6	4.2	3.9	4.3	11.3	6.3	7.7	7.6	9.1	
529	26-3200-5840-7	6.1	6.4	6.1	11.2	6.3	7.2	6.5	8.4	
531	26-3200-5840-8	6.3	6.2	6.0	10.2	6.3	5.1	8.1	6.2	
533	23-1440-5840-5	4.9	5.9	4.6	11.1	6.3	5.0	5.9	8.1	
535	23-1440-5840-4	3.3	3.6	3.5	8.0	5.6	4.5	5.9	7.5	
536	05-1440-3200-2	6.2	6.1	5.8	10.6	5.9	6.4	9.9	9.1	
537	23-3200-5840-2	3.8	4.3	3.9	7.2	5.0	4.1	4.2	4.9	
539	24-4960-4960-1	8.1	9.5	8.7	13.4	5.1	5.6	6.6	11.3	
541	24-4960-4960-2	5.1	6.2	6.5	11.2	5.0	7.0	7.7	9.3	
543	23-4960-1440-2	7.1	8.2	5.4	12.1	6.8	5.2	5.0	5.3	

(continued)

Sample No.	Site designation	Median top growth[a]				Maximum root growth[b]				Notes[c]
		Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
545	23-1440-5840-1	7.2	9.0	5.3	12.8	4.1	6.2	3.2	11.3	
547	23-1440-5840-2	5.5	5.0	4.8	10.2	7.1	5.3	5.3	7.3	
549	23-2320-5840-1	5.4	5.6	4.9	9.8	4.5	7.1	11.2	9.6	
551	26-5840-4520-1	8.9	10.5	11.4	13.2	6.0	6.1	9.3	12.1	
553	26-5840-4520-2	7.9	9.9	7.1	12.1	6.0	4.1	6.0	7.9	
555	26-5840-4520-3	6.3	5.9	8.2	11.4	5.1	4.2	6.8	9.1	
557	26-3640-5840-5	4.3	4.7	7.9	10.2	5.2	6.5	7.3	9.1	
559	23-5840-1440-6	3.8	4.6	4.9	11.8	6.8	7.0	6.5	8.8	
561	23-5840-1440-3	4.2	5.9	4.1	10.2	4.7	7.2	8.0	8.2	
563	23-4960-1440-3	3.4	4.2	3.6	8.1	5.1	6.4	6.4	6.6	
565	24-1440-4960-4	5.8	5.7	5.9	10.1	7.6	5.1	7.0	8.1	
566	23-4960-1440-5	4.6	6.2	5.2	10.9	6.0	6.9	7.1	6.9	
567	23-5840-1440-5	4.8	4.9	4.1	11.5	4.6	6.9	7.2	7.3	
569	26-4080-5400-2	8.1	7.5	7.8	12.1	4.0	5.9	11.9	9.1	
571	26-4080-5400-5	5.0	6.1	6.7	11.0	3.9	8.5	7.9	7.9	
573	36-1880-1030-3	3.2	3.4	3.0	7.5	4.4	5.1	6.2	6.1	
575	06-5400-3640-1	6.8	7.6	4.5	10.8	6.8	6.7	3.4	8.1	
577	06-5400-4960-2	6.2	6.8	5.2	12.1	6.6	8.1	6.7	8.4	
579	06-5400-4960-1	7.9	8.1	8.9	12.8	5.7	6.9	8.5	10.3	
581	26-3640-5840-3	5.4	6.8	6.6	11.9	5.0	5.8	6.0	9.7	
583	23-5840-1440-1	7.8	9.1	8.2	13.1	5.5	6.4	8.3	7.0	
585	23-5840-1440-4	3.9	4.6	4.1	9.8	6.1	6.2	9.1	10.1	
587	26-3200-5840-5	6.1	6.5	6.2	13.2	5.9	4.5	7.1	9.2	
589	26-3200-5840-4	5.2	6.5	6.4	10.9	4.9	5.3	5.9	8.4	
591	26-3200-5840-1	8.4	9.3	10.1	14.1	5.8	6.4	8.6	7.6	
593	26-3640-5840-7	5.3	6.4	6.3	12.1	5.1	7.3	10.4	9.3	
595	36-1440-2760-1	6.3	5.2	6.0	12.8	4.8	6.4	8.9	10.8	
597	36-1440-2760-2	4.9	5.1	5.2	11.1	2.4	7.2	9.5	6.6	
599	23-1440-5840-3	5.9	5.8	5.6	11.9	5.6	7.3	7.1	7.4	
600	23-5840-5840-5	4.5	5.7	6.3	11.6	13.1	8.5	8.6	9.6	

(continued)

Sample No.	Site designation	Median top growth[a]				Maximum root growth[b]				Notes[c]
		Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
601	24-1440-4960-3	3.9	5.1	4.6	10.3	4.9	5.3	7.9	5.9	
602	23-4960-5840-2	6.8	7.5	7.3	12.9	4.3	5.4	8.3	10.1	
603	24-1440-4960-2	6.7	7.4	7.5	12.0	5.9	7.5	7.3	9.2	
605	26-3200-5840-3	3.5	4.1	4.1	7.2	5.5	6.0	6.5	6.5	
607	26-3200-5840-2	7.6	8.2	7.4	11.8	4.0	4.5	8.1	5.5	
609	36-2760-1030-3	4.2	5.1	5.8	12.8	4.5	3.9	5.5	7.5	
Control A		10.2	10.1	11.8	13.1	6.1	6.9	8.5	10.3	
Control B		9.8	9.4	10.4	12.8	6.3	9.3	8.3	8.8	

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth: maximum root length of test plants measured 3 weeks after planting.

[c] Notes: A - root hair suppression on sugar beet; B - "clubbing" and root stunting on grasses.

Table B-12. Results of primary test number 12 indicating growth measurements recorded on test plants planted 7/28/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Median top growth[a]				Maximum root growth[b]				Notes
		Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
611	36-1440-1440-3	6.3	6.8	8.1	11.7	5.0	5.0	7.0	9.7	
613	36-1880-2760-2	5.1	4.6	4.3	4.2	4.9	5.1	4.2	3.1	
615	36-1440-1880-2	6.3	6.5	7.6	11.6	6.0	7.9	9.5	11.6	
617	26-5840-4520-7	5.2	6.4	6.5	9.8	6.2	8.2	8.5	9.5	
619	36-2760-1030-1	5.9	6.5	6.7	12.2	3.2	5.5	9.1	9.9	
621	36-2760-1030-2	4.2	5.3	5.9	9.2	4.3	7.6	8.1	10.4	
623	36-3200-1030-2	7.9	8.1	13.1	13.2	2.7	5.3	10.6	7.2	
625	36-3200-1030-1	6.9	9.2	13.4	12.6	4.5	5.3	9.6	10.3	
627	36-1880-2760-1	2.0	0.1	1.6	2.6	1.3	0.3	1.3	0.2	
629	36-1440-1440-1	6.8	6.6	6.2	7.1	4.1	7.2	5.1	3.5	
631	36-1440-2320-1	9.8	10.3	12.1	13.2	5.1	5.5	11.6	10.3	
633	23-4080-1440-7	5.3	5.6	7.8	10.8	4.7	7.6	8.0	8.9	
635	36-1440-1440-2	5.6	6.7	6.4	11.1	4.6	7.2	5.6	12.7	
637	36-1440-1880-3	5.2	5.9	5.1	8.5	8.9	7.4	7.3	8.1	
639	26-3640-5840-1	0	8.2	9.8	9.4	0	5.1	8.6	7.0	
641	23-4960-5840-3	4.6	4.7	4.6	9.6	6.0	5.8	5.7	8.5	
642	23-4080-5840-1	7.1	6.9	6.8	10.2	5.6	4.9	7.7	11.6	
643	24-5840-4960-1	6.1	7.2	7.9	10.4	4.7	5.7	9.3	12.3	
645	24-5840-4960-2	5.2	6.4	6.9	10.5	4.7	7.2	8.7	9.6	
647	36-1440-1030-4	5.6	6.4	6.2	12.4	5.3	5.7	9.2	10.1	
649	36-1440-1880-1	7.3	7.0	10.1	12.1	6.5	5.2	9.5	9.3	
651	26-3640-5840-8	4.5	4.9	6.9	9.8	4.5	6.1	6.6	7.1	
653	36-1440-1030-2	6.2	6.3	4.2	6.3	5.1	6.4	3.2	4.5	
655	36-1440-2320-2	5.6	5.7	8.6	12.5	5.3	5.5	9.2	8.9	
657	36-1440-2760-3	5.1	5.1	5.3	10.8	4.2	4.7	7.6	10.9	
659	23-3200-5840-3	4.9	4.1	4.9	7.6	4.3	4.3	4.3	10.2	
661	24-1440-4960-1	6.1	7.0	8.2	11.1	4.3	4.5	10.4	9.6	
663	24-2320-4960-1	7.3	7.4	8.0	12.1	6.7	7.4	9.2	7.4	

(continued)

Sample No.	Site designation	Median top growth[a]				Maximum root growth[b]				Notes
		Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
665	23-4080-1440-3	5.6	5.5	10.1	12.4	4.0	7.3	9.0	9.3	
667	23-4080-1440-6	5.1	6.1	11.2	11.8	6.2	6.2	7.4	9.4	
669	23-4080-1440-2	6.8	9.1	5.2	11.9	4.9	7.0	5.6	8.2	
671	23-5840-5840-1	7.1	8.2	7.9	11.6	5.4	6.6	5.7	10.6	
673	23-5840-5840-3	4.9	6.1	6.6	8.9	5.9	5.6	8.5	11.2	
675	23-5840-5840-2	4.9	4.8	5.1	8.7	4.0	4.8	5.3	8.2	
Control	A	8.1	7.9	12.1	13.1	4.2	7.0	8.9	9.7	
Control	B	7.2	8.3	13.1	13.8	3.8	5.9	8.9	9.1	

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth: maximum root length of test plants measured 3 weeks after planting.

Table B-13. Results of primary test number 13 indicating growth measurements recorded on test plants planted 8/26/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No	Site designation	Median top growth[a]				Maximum root growth[b]				Notes
		Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
677	26-4080-3200-6	2.2	2.7	3.0	5.6	4.1	6.1	4.3	7.9	
679	26-4080-3200-2	1.5	0.7	2.1	4.2	4.3	2.4	3.9	6.1	
681	26-4960-5400-7	3.0	2.3	2.5	5.3	4.0	5.0	8.2	8.5	
682	26-3200-3200-3	0	0	0	0	0	0	0	0	
683	36-3200-1030-3	3.4	3.6	4.7	5.7	5.8	8.7	8.8	15.5	
685	36-3200-1440-2	2.6	2.6	2.6	5.8	6.2	7.4	7.6	9.4	
687	36-3200-1440-1	4.3	3.7	1.2	6.5	6.3	6.1	2.1	7.7	
689	24-1440-3200-4	3.2	3.1	3.0	6.2	4.8	9.6	3.3	12.1	
691	24-1440-3200-5	2.5	2.3	3.7	4.7	8.5	9.5	10.4	14.4	
693	24-1440-3200-5	2.6	3.0	3.3	7.3	7.1	6.0	8.3	10.6	
695	24-1440-4080-4	3.0	3.0	2.8	5.5	4.3	7.1	10.3	9.6	
696	24-4520-5400-7	2.2	2.5	3.7	5.2	4.1	8.9	13.6	14.0	
697	26-4960-5400-8	2.5	1.7	2.0	7.2	5.4	6.0	1.7	11.2	
699	26-3200-3200-7	2.9	2.6	3.0	6.5	3.5	6.6	10.0	10.9	
701	26-4080-3200-7	2.8	2.6	2.5	6.5	2.7	8.2	6.1	11.2	
703	26-3640-3200-7	2.1	2.5	3.2	6.1	4.2	8.9	5.2	9.3	
704	26-4080-3200-4	2.5	2.5	2.5	6.3	1.2	7.7	6.9	10.0	
705	26-4080-3200-8	2.5	2.8	3.2	5.6	3.6	5.7	5.3	9.7	
707	36-3200-1030-4	2.8	3.2	0	6.7	4.2	2.4	0	8.2	
709	36-3200-1440-3	4.2	3.7	4.5	4.5	3.2	6.0	7.1	5.6	
711	36-3200-1440-4	2.5	2.3	1.7	5.6	2.0	8.6	6.0	6.5	
713	26-3640-3200-6	3.0	2.6	3.6	7.0	4.6	6.7	9.0	8.8	
715	26-3640-3200-4	3.5	3.2	4.5	7.0	8.2	12.2	7.3	8.8	
716	26-3640-3200-9	3.3	3.5	3.4	7.0	4.0	3.6	9.4	17.0	
717	26-3200-3200-8	2.4	2.6	2.0	3.1	5.0	8.8	6.4	4.6	
718	26-3200-3200-2	1.5	1.9	1.4	0	2.4	3.8	2.2	0	
719	26-3200-3200-6	3.2	2.0	3.7	7.2	3.6	7.6	10.1	9.3	
721	26-4960-5400-10	3.0	2.2	2.6	6.0	3.0	6.8	9.2	10.1	

(continued)

Sample No.	Site designation	Median top growth[a]				Maximum root growth[b]				Notes
		Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
722	26-4960-5400-9	2.3	2.0	3.3	5.4	4.0	4.0	7.2	7.9	
723	26-4960-5400-6	2.7	2.5	2.5	5.5	6.6	7.1	11.2	10.0	
724	24-1440-3200-6	2.6	2.1	3.5	6.8	2.6	4.7	7.9	12.6	
725	24-2320-4080-5	1.3	2.9	3.0	6.1	2.2	4.4	4.1	7.6	
727	26-3200-3200-4	2.2	1.3	1.1	4.9	3.0	3.6	3.5	8.2	
729	24-2320-4080-4	2.5	2.3	2.6	5.6	8.1	4.6	12.8	16.0	
731	26-3640-3200-8	2.2	1.9	3.7	7.5	5.0	6.8	10.1	7.5	
733	26-4520-5400-8	2.7	2.5	3.5	5.5	5.2	11.7	10.2	9.8	
735	26-3640-3200-2	2.5	2.4	2.6	5.5	10.1	7.3	15.4	16.0	
737	26-3640-3200-3	3.7	3.2	4.2	6.5	5.6	7.4	11.5	18.5	
739	26-3640-3200-1	2.5	0	0	3.7	5.6	0	2.3	6.5	
741	26-3640-3200-5	3.3	3.0	4.0	7.5	5.8	7.6	9.2	2.0	
743	26-2760-3200-4	2.5	2.3	3.2	6.1	3.8	4.8	12.3	13.2	
745	26-2760-3200-5	2.2	2.2	4.7	7.0	8.1	9.2	10.0	14.0	
747	26-2760-3200-6	3.2	2.6	5.5	7.0	7.1	7.5	11.3	11.5	
749	26-2760-3200-2	4.0	4.0	3.1	9.0	4.5	7.2	10.3	20.3	
751	26-2760-3200-3	2.7	2.2	2.4	5.6	5.6	6.0	8.3	8.2	
753	26-4520-5400-9	2.5	2.3	4.0	6.5	5.3	9.4	9.2	9.1	
755	26-4520-5400-6	2.0	2.5	2.0	4.7	3.5	5.3	5.1	11.2	
757	23-5840-3200-5	3.2	3.0	3.5	7.5	7.5	12.5	10.7	11.9	
758	26-3640-5840-4	2.4	2.6	2.7	6.5	3.9	8.1	9.1	15.0	
759	23-5840-3200-4	3.5	2.7	4.1	7.5	11.2	4.5	15.0	14.2	
761	26-2760-3200-9	3.3	3.3	2.7	2.2	3.7	4.8	6.1	1.5	
762	26-2760-3200-8	2.7	2.7	3.6	6.0	3.3	5.1	4.0	7.1	
763	26-2760-3200-7	2.7	2.2	3.5	6.0	2.3	5.4	4.6	7.2	
765	26-2760-3200-1	3.0	4.9	8.0	8.0	2.7	6.6	8.6	9.5	
Control A		5.7	6.2	8.0	12.0	4.5	4.3	6.1	5.0	
Control B		6.5	7.0	10.0	10.0	3.9	4.5	6.3	6.6	

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth: maximum root length of test plants measured 3 weeks after planting.

Table B-14. Results of primary test number 14 indicating growth measurements recorded on test plants planted 8/27/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Median top growth[a]				Maximum root growth[b]				Notes
		Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
767	26-4080-3200-1	3.5	2.0	2.1	4.7	5.5	3.0	2.1	4.6	
769	26-4080-3200-3	2.1	2.1	3.5	7.5	4.6	5.7	16.5	18.0	
771	26-4080-3200-5	2.4	2.3	3.5	6.5	4.0	8.7	10.3	10.5	
773	23-5840-2320-5	2.5	2.8	6.0	3.5	5.0	5.6	3.7	5.0	
775	26-3200-3200-5	2.4	1.9	1.5	5.6	4.6	4.0	3.9	11.5	
777	26-3200-3200-1	3.5	3.4	0	5.0	3.0	5.0	0	8.0	
779	23-4960-2320-5	2.5	2.2	3.0	7.3	6.6	5.6	9.7	12.1	
Control A		4.6	4.6	6.2	7.2	3.0	10.7	3.3	5.7	
Control B		3.7	4.6	5.1	8.0	4.0	4.0	7.1	8.3	

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth: maximum root length of test plants measured 3 weeks after planting.

Table B-15. Results of primary test number 15 indicating growth measurements recorded on test plants planted 9/1/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No	Site designation	Median top growth[a]				Maximum root growth[b]				Notes
		Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
488	05-1880-3640-1	2.4	2.5	3.1	4.0	5.5	7.7	6.1	12.5	
Control A		3.6	4.0	5.5	8.0	2.8	5.1	6.8	9.9	
Control B		3.7	3.9	3.5	6.8	3.0	7.5	7.5	7.3	

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth: maximum root length of test plants measured 3 weeks after planting.

Table B-16. Results of secondary test number 1 indicating growth measurements recorded on test plants planted 4/13/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No	Site designation	Median top growth[a]				Maximum root growth[b]				Notes[c]
		Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
1	36-1880-4080-2	6.5	6.0	7.5	12.2	5.1	4.9	4.2	10.3	
2	36-1880-4080-1	7.8	5.8	4.6	12.5	4.5	5.1	3.7	4.0	
3	36-2320-4520-2	6.2	6.4	6.5	12.3	2.4	5.5	3.2	8.6	
5	36-1440-4080-1	0	8.2	5.8	12.2	0	4.2	1.6	6.1	
7	36-1440-3640-2	6.4	6.9	6.6	12.3	4.6	5.7	7.1	9.1	
9	36-1440-3640-1	7.9	3.3	2.4	12.2	4.2	3.1	5.7	2.8	
11	36-1440-4080-2	7.2	6.5	7.6	13.1	5.9	5.2	5.2	9.4	
13	36-1440-5400-1	6.6	7.7	7.6	13.2	6.9	8.3	7.2	10.1	
14	36-1440-5400-2	7.5	6.8	6.8	12.1	4.2	7.5	5.3	12.4	
15	36-2760-5400-1	6.8	7.2	7.2	12.1	3.2	6.3	5.1	7.1	
16	36-2760-5400-2	7.2	6.2	7.2	13.5	4.1	3.9	5.9	8.1	
17	36-3200-5400-1	7.5	6.8	7.5	12.5	2.0	4.3	5.1	8.5	
18	36-3200-5400-2	6.7	7.2	5.4	13.3	6.2	5.2	3.4	5.5	
19	36-2760-5840-1	7.2	7.3	6.6	13.1	3.1	2.9	4.8	6.5	
20	36-2760-5480-2	6.6	6.5	8.2	12.6	4.1	5.1	4.4	11.7	
21	36-2320-5840-1	7.5	6.5	8.2	13.2	3.8	6.5	6.2	7.1	
22	36-1440-4960-2	12.4	8.6	8.1	7.3	7.2	4.2	6.2	7.1	
23	36-3200-4960-1	10.6	8.9	7.8	8.3	5.4	6.1	3.7	2.7	
24	36-3200-4960-2	6.4	8.6	8.6	12.4	7.3	5.1	5.7	7.3	
25	36-1030-4080-1	7.3	7.6	8.1	13.5	5.1	5.3	6.7	7.0	
27	36-1050-1440-1	7.4	8.1	8.1	12.1	4.1	4.7	4.8	4.7	
28	36-1030-4520-1	8.0	8.2	8.5	10.1	5.1	4.5	4.6	7.1	
30	36-1440-3200-1	7.3	7.4	3.2	11.5	4.2	5.2	0.9	4.2	
31	36-2320-3200-1	5.9	3.6	0	6.2	1.8	0.7	0	0.7	A
32	36-2760-2320-1	5.2	4.7	0	9.5	2.9	2.0	0	4.0	
33	36-2320-2320-2	5.2	4.9	0	9.6	2.9	2.1	0	4.7	
35	36-2760-2320-2	5.6	5.2	6.1	11.1	4.1	4.4	2.9	6.0	

(continued)

Sample No.	Site designation	Median top growth[a]				Maximum root growth[b]				Notes[c]
		Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
37	36-2320-3640-1	6.3	5.7	5.3	9.1	4.1	4.2	2.6	4.0	
39	36-1880-2320-1	9.1	2.0	3.1	11.1	3.1	2.3	3.0	7.9	
41	36-1880-2320-2	5.1	--	2.4	12.2	2.0	--	1.2	6.5	
Control A		7.2	6.9	6.5	13.3	3.1	2.9	4.8	6.5	
Control B		4.2	4.0	0	8.5	3.5	1.0	0	4.1	

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth: maximum root length of test plants measured 3 weeks after planting.

[c] Notes: A - suppressed root development on sugar beet, mustard and ryegrass, "clubbing" of ryegrass.

Table B-17. Results of secondary test number 2 indicating growth measurements recorded on test plants planted 4/21/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No.	Site designation	Median top growth[a]				Maximum root growth[b]				Notes
		Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
46	36-2320-1440-2	1.2	1.5	0	4.5	1.5	2.1	0	0.4	
59	36-2320-1440-1	1.6	2.5	0	0	0.5	0.7	0	0	
Control A		8.1	10.2	9.7	15.2	5.7	6.9	6.2	10.4	
Control B		7.2	10.0	5.8	13.5	3.4	8.9	3.2	6.2	

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth: maximum root length of test plants measured 3 weeks after planting.

Table B-18. Results of secondary test number 3 indicating growth measurements recorded on test plants planted 6/8/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No	Site designation	Median top growth[a]				Maximum root growth[b]				Notes
		Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
63	36-1880-3640-2	6.5	7.0	3.5	4.4	3.5	5.5	1.1	0.5	
239	24-2320-3200-3	3.3	5.0	5.0	7.6	3.4	4.0	2.0	0.5	
260	36-2320-1880-2	2.1	3.5	1.2	3.1	0.7	0.7	0.2	0.4	
331	36-2320-1880-1	0	0	0	0	0	0	0	0	
Control A		8.4	8.0	13.2	15.4	5.0	4.1	3.8	9.1	
Control B		9.0	14.5	15.0	7.0	3.0	4.3	5.5	10.1	

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth; maximum root length of test plants measured 3 weeks after planting.

Table B-19. Results of secondary test number 4 indicating growth measurements recorded on test plants planted 6/18/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No	Site designation	Median top growth[a]				Maximum root growth[b]				Notes
		Sugar beet	Mustard	Millet	Ryegrass	Sugar beet	Mustard	Millet	Ryegrass	
440	09-4201-1299-1	4.7	4.2	5.7	6.9	0.9	2.7	1.5	4.6	
Control A No sand		9.8	8.7	14.2	15.2	3.8	7.0	6.3	10.3	
Control B Sand		9.5	9.3	14.9	16.5	5.4	4.9	7.8	10.4	
Control C Sand		8.5	8.5	15.5	17.1	3.5	6.9	9.5	13.1	

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth: maximum root length of test plants measured 3 weeks after planting.

Table B-20. Results of secondary test number 5 indicating growth measurements recorded on test plants planted 9/20/76 and grown for 3 weeks in soil samples collected at selected sites at the Rocky Mountain Arsenal.

Sample No	Site designation	Median top growth[a]				Maximum root growth[b]				Notes[c]
		Sugar beet	Mus-tard	Millet	Rye-grass	Sugar beet	Mus-tard	Millet	Rye-grass	
460	36-1880-1880-1	5.5	6.9	7.2	8.3	2.0	4.9	2.8	2.3	A
514	36-1440-1030-1	6.4	6.2	4.2	6.6	3.8	3.1	1.2	0.7	A
606	26-3200-5840-3	5.6	6.1	6.1	9.1	3.4	2.2	2.5	2.7	
628	36-1880-2760-1	2.6	0.6	1.5	4.2	1.6	0.9	0.6	1.0	
680	26-4080-3200-2	4.3	4.0	5.3	9.3	1.5	1.5	2.0	2.9	
682	26-3200-3200-3	2.9	3.0	0	6.5	0.3	0.7	0	4.8	B
690	24-1440-3200-4	6.2	7.1	6.8	10.9	3.0	3.3	3.9	8.6	
696	24-4520-5400-7	5.6	5.6	9.1	10.2	2.1	5.3	4.1	9.4	
698	26-4960-5400-8	6.5	8.1	7.7	10.2	4.0	3.2	4.0	4.3	
708	36-3200-1030-4	5.5	6.6	8.1	9.5	3.1	2.0	2.3	3.9	
712	36-3200-1440-4	5.0	7.1	6.3	10.9	2.3	4.0	2.7	4.0	
726	24-2320-4080-5	5.9	6.5	8.1	10.3	3.1	2.3	3.1	3.4	
732	26-3640-3200-8	5.4	5.7	7.0	13.1	1.7	2.4	4.9	5.2	
738	26-3640-3200-3	5.0	6.2	6.4	10.1	2.3	2.4	3.9	2.5	
740	26-3640-3200-1	0	0	0	0	0	0	0	0	
758	26-3640-5840-4	5.6	6.9	5.1	6.5	1.5	3.9	3.0	3.4	
761	26-2760-3200-9	5.9	6.1	8.7	9.1	4.7	4.7	5.2	7.1	
764	26-2760-3200-7	5.1	6.3	6.9	8.1	4.5	3.3	2.9	2.3	
768	26-4080-3200-1	4.9	3.4	2.6	8.1	4.0	2.5	1.6	4.1	
774	23-5840-2320-5	6.2	7.0	7.0	9.6	3.0	4.9	2.7	4.1	
778	26-3200-3200-1	3.9	2.9	5.1	8.9	1.9	1.9	2.2	3.6	
Control A		6.3	6.9	8.7	9.4	3.6	2.1	3.9	6.7	
Control B		6.6	7.5	8.4	11.2	3.3	4.4	8.4	5.5	

[a] Median top growth: median height of test plants measured 3 weeks after planting.

[b] Maximum root growth: maximum root length of test plants measured 3 weeks after planting.

[c] Notes: A - root stunting and "clubbing" on millet and ryegrass; B - severe stunting on roots of mustard.

APPENDIX C

GLOSSARY

Appendix C is a glossary of terms used to indicate growth and development of plants grown in test soils from RMA. The probable phytotoxicity ratings for various soils were established by observation of emergence and growth at weekly intervals, measurements of plant tops and roots following three weeks growth, and recognition of symptoms to distinguish between phytotoxin and other environmental stress injury.

In Appendices A and B several terms were used to describe similar phenomena. In this glossary, terms having the same meaning are listed as synonyms to the preferred term. Where possible, term definitions differentiate whether the term describes plant injury due to phytotoxins or other environmental stresses.

GLOSSARY

Chlorosis - absence or loss of chlorophyll from leaves and stems.

Clubbing - see clubbing of roots.

Clubbing of roots - deformation of plant roots during development where roots are shortened in length and enlarged in circumference. Synonym: clubbing.

Damping-off disease - death of newly emerged seedlings associated with growth environment but not due to phytotoxins in soil.

Decreased growth - small increase in plant size that was less than growth of control plants.

Delayed or inhibited germination due to wetting problems - failure of seeds to germinate and seedlings to emerge from soil at rate evident in control plantings because of physical properties of soil preventing moisture uptake by roots. Does not indicate presence of phototoxins.

Emergence - penetration of plant up through soil as result of seed germination and initial seedling growth.

Epinasty - downward bending of plant leaves and petioles associated with growth differential in upper and lower sides. Probably due to presence of phytotoxins.

Extreme suppression of root growth - see severe root reduction.

Foreign odor - distinct abnormal emanation from soil as sensed by the nose.

Growth - increase in plant size.

Hypocotyl swelling - localized increase in size of dicot plant hypotocyls due to cell enlargement or cell division, probably due to presence of phyhtotoxins.

Leaf tip necrosis - death of cell tissue on grass leaf tips.

Leaf necrosis by disease organism - death of cell tissue in leaves due to phytotoxic effects of disease organisms.

Maximum root growth - greatest length of plant roots.

Median top growth - measure of top growth constituting the middle value of plants within the test.

Necrosis - death of cell tissue in leaves and stems.

No growth - failure of plants to increase in size.

Purple pigmentation - development of purple coloration in leaves and stems. Probably not due to presence of phytotoxins.

Reduced root growth - see suppressed root development.

Root growth greatly suppressed - see severe root reduction.

Root growth inhibition - see suppressed root development.

Root growth suppression - see suppressed root development.

Root hair suppression - see suppression of root hair production.

Root stunting - retarded development of main and branch roots relative to control plants.

Severe root reduction - large decrease in root growth as evidenced by greatly reduced length as compared with controls. Synonyms: root growth greatly suppressed, extreme suppression of root growth.

Severe root stunting - extreme retardation of main and branch roots relative to control plants.

Stunting - reduction in plant height.

Stunting resembling that produced by herbicide - reduction in plant height in a manner similar to that previously observed when plants were grown in soil containing herbicides.

Suppressed root development - decrease in root growth as evidenced by reduced length as compared with controls. Synonyms: suppression of root growth, root growth suppression, root growth inhibition, reduced root growth.

Suppression of root growth - see suppressed root development.

Suppression of root hair production - failure of root hairs to develop on roots. Synonym: root hair suppression.

Yellowing - loss of chlorophyll and development of yellow coloration primarily in lower leaves. Synonym: chlorosis.

Yellowing distinct from herbicide - yellowing probably associated with soil mineral deficiencies. Synonym: induced chlorosis.

APPENDIX D

ENVIRONMENTAL FACTORS RESTRICTING INTERPRETATION OF PLANT SIGNS AS INDICATORS OF THE PRESENCE OF PHYTOTOXINS

The investigator must use extreme care in distinguishing phytotoxicity or growth changes in plants from those having other causes. Many environmental conditions occur which can alter test plant growth from that of control plants growing in greenhouse compost and thus give symptoms indicating phytotoxins where none exist. Table D-1 is a summary of soil, atmosphere, and plant variables that can give false signs. Table D-2 is a listing of plant signs observed in the present study that could be related to non-phytotoxic causes.

Not all possible plant signs resulting from various environmental conditions are presented. Many signs are specific for one or only a few types of plants. Some signs only express themselves as the plant continues to grow and develop through maturity and seed production and thus would not be evident in the present study where plants were grown only 3 weeks. Naturally occuring concentrations of heavy metals, plant nutrients, and plant residues can cause phytotoxic activities at Rocky Mountain Arsenal.

For more complete descriptions of environmental factors restricting interpretation of phytotoxic plant signs, the reader should examine the listed references.

TABLE D-1

ENVIRONMENTAL FACTORS RESTRICTING INTERPRETATION OF PLANT SIGNS AS INDICATORS OF THE PRESENCE OF PHYTOTOXINS

Factors	Limiting Conditions	Environmental Modifications	Plant Signs	References
Soil				
texture and structure	retention and infiltration of H_2O	reduced availability of H_2O	dessication of leaves and stems, reduced growth, failure to germinate and emerge, early senescence	14, 23
	physical characteristics	function of soil crusts and hard pans that reduce ability of plant tissue to penetrate through soil	failure to emerge, stunted and malformed growth	14, 23
atmosphere	gas exchange in root zone	reduced availability of oxygen and accumulation of carbon dioxide and ethylene	reduced growth, stunted roots, chlorosis	14, 23
acidity and alkalinity	soil pH	$4 > pH > 8$ Other values are detrimental	chlorosis, reduced growth, failure to germinate and emerge.	3, 14, 23
	solubility of nutrients	reduced availability of Fe^{+2}, $^{+3}$, Mn^{+2}, Cu^{+2} in alkaline soils, toxic concentrations of Al^{+3} in alkaline soils	death of terminal tissue, chlorosis	3, 11, 14, 23
	solubility of carbonates	reduced availability of Fe	chlorosis, reduced growth	3
clays and organic matter	absorptive and adsorptive	reduced concentration of phytotoxin through sorption to clay particles and organic matter	normal growth and development	23
	exchange capacity	low exchange capacity can lead to rapid leaching of soil nutrients	reduced growth and development	14, 23

TABLE D-1 (Continued)

Factors	Limiting Conditions	Environmental Modifications	Plant Signs	References
moisture	drought conditions	reduced availability of H_2O	leaf tip necrosis, dessication of leaves and stems, reduced growth, failure to germinate and emerge, early senescence	14, 23
	flooded conditions	saturation of soil pore spaces, reduced availability of oxygen	reduced growth, stunted roots, chlorosis, failure to germinate and emerge, necrosis	14, 23
nutritional status	availability of necessary nutrients for plant growth	deficiencies of mineral nutrients		
		nitrogen	pale green, yellow or red leaves; reduced leaf size; abscission; stunting of plant growth; reduced yields	3, 10, 11, 12, 14
		phosphorous	purplish leaves and stems, retarded growth and maturity, reduced yields	3, 10, 11, 12, 14
		potassium	yellow or brown edged leaves; mottled, spotted or curled leaves, appearing on older leaves first; chlorotic spots; poor root system; reduced yields	3, 10, 11, 12, 14
		calcium	pale green leaves, necrotic leaf spots, reduced root growth, deformed terminal leaves and branches, reduced yields	3, 10, 11, 12, 14
		magnesium	chlorosis, reduced growth, reduced yields	3, 10, 11, 12, 14
		sulfur	pale green leaves	3, 10, 11, 12, 14
		iron	pale green leaves, chlorosis, alternate rows of green and white in grass leaves	3, 10, 11, 12, 14
		boron	necrosis of terminal buds; thickened, curled, and brittle leaves	3, 10, 11, 12, 14

TABLE D-1 (Continued)

Factors	Limiting Conditions	Environmental Modifications	Plant Signs	References
		manganese	pale green interveinous leaf tissue; brownish, black or gray spots next to leaf veins	3, 10, 11, 12, 14
		zinc	chlorotic areas in leaves, rusty brown flecks on leaves, reduced growth	3, 10, 11, 12, 14
		molybdenum	pale green leaves, rolled or cupped leaf margins, yellow spots on leaves	3, 10, 11, 12, 14
		copper	necrosis of terminal tissue, chlorotic or stripped leaves	3, 10, 11, 12, 14
		chloride	wilting, stubly roots, chlorosis and bronzing of leaf tissue	3, 10, 11, 12, 14
organisms	pathogenic species and sensitivity of plants	plant diseases, soil fungi, nematodes	stunting, die back of tissues, necrosis of germinating or seedling tissues	14
Atmospheric				
light	photosynthesis	low light levels	internodal elongation, partially expanded leaves, page green stem and leaves, poorly developed root system	14
	growth regulation	wavelength of light	failure to flower or become dormant in some species	14
temperature	average temperature	low	failure to germinate, slow plant growth	14
		high	failure to germinate, slow plant growth	14
	extremes	freeezing and chilling injury	death of tissue, necrotic spots on leaves, stunting	14
		high temperatures	wilting of leaves, death of tissue, stunting	14
relative humidity	transpiration rate	low relative humidity	wilting of leaves, stunting	14
oxygen	respiration rate	low O_2	failure to germinate, stunting	14

TABLE D-1 (Continued)

Factors	Limiting Conditions	Environmental Modifications	Plant Signs	References
carbon dioxide	photosynthesis	low	stunting	14
air pollutants	sensitivity of plant tissue	type, concentration and length of	spotting of leaves, necrosis and chlorosis of leaf tissue, stunting,	13, 16
organisms	pathogenic species, sensitivity of plant	plant diseas, insects, other predators	necrosis of tissue or plant, failure to germinate, defoliation	14
	competitive plants	seedling rates	stunting	14, 15
Plant				
class, type, species, cultivar, seed source	angiosperm, gymnosperm, vascular, non-vascular monocot and dicot, and other physiological or morphological differences	differential susceptibility	growth and development normal	2, 13, 15, 16
seed	size	penetration of phytotoxin into seed reduced with larger seed, large seeds have more vigorous growing seedlings	growth and development normal	2, 15
metabolism, age, growth	rate, pathways	slower rates make some plants less susceptible, plants may have pathways allowing breakdown of phytotoxins to non-phyto-toxic compounds	growth and development normal	2, 15

TABLE D-2

CROSS REFERENCE OF PLANT SIGNS WHICH MAY BE CONFUSED WITH PHYTOTOXICITY WHEN COMPARED TO CONTROL PLANTS GROWING IN POTTING COMPOST

Plant Sign	Possible Cause
Chlorosis	nutritional deficiencies, unfavorable soil pH, flooding or drought conditions
Decreased growth	nutritional deficiences, unfavorable soil pH, flooding or drought conditions
Leaf tip necrosis	nutritional deficiencies, drought conditions
Necrosis	nutritional deficiencies, drought conditions, pathogenic organisms
No growth	nutritional deficiencies, unfavorable soil pH, flooding or drought conditions, pathogenic organisms
Purple pigmentation	nutritional deficiencies
Root stunting	nutritional deficiencies, unfavorable soil pH, flooding or drought conditions, pathogenic organisms, poor soil aeration
Root reduction	nutritional deficiencies, unfavorable soil pH, flooding or drought conditions, pathogenic organisms, poor soil aeration
Stunting	nutritional deficiencies, unfavorable soil pH, flooding or drought conditions, pathogenic organisms, poor soil aeration
Suppressed root development	nutritional deficiencies, unfavorable soil pH, flooding or drought conditions, pathogenic organisms, poor soil aeration
Suppressed root hair production	nutritional deficiencies, unfavorable soil pH, flooding or drought conditions, pathogenic organisms, poor soil aeration

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